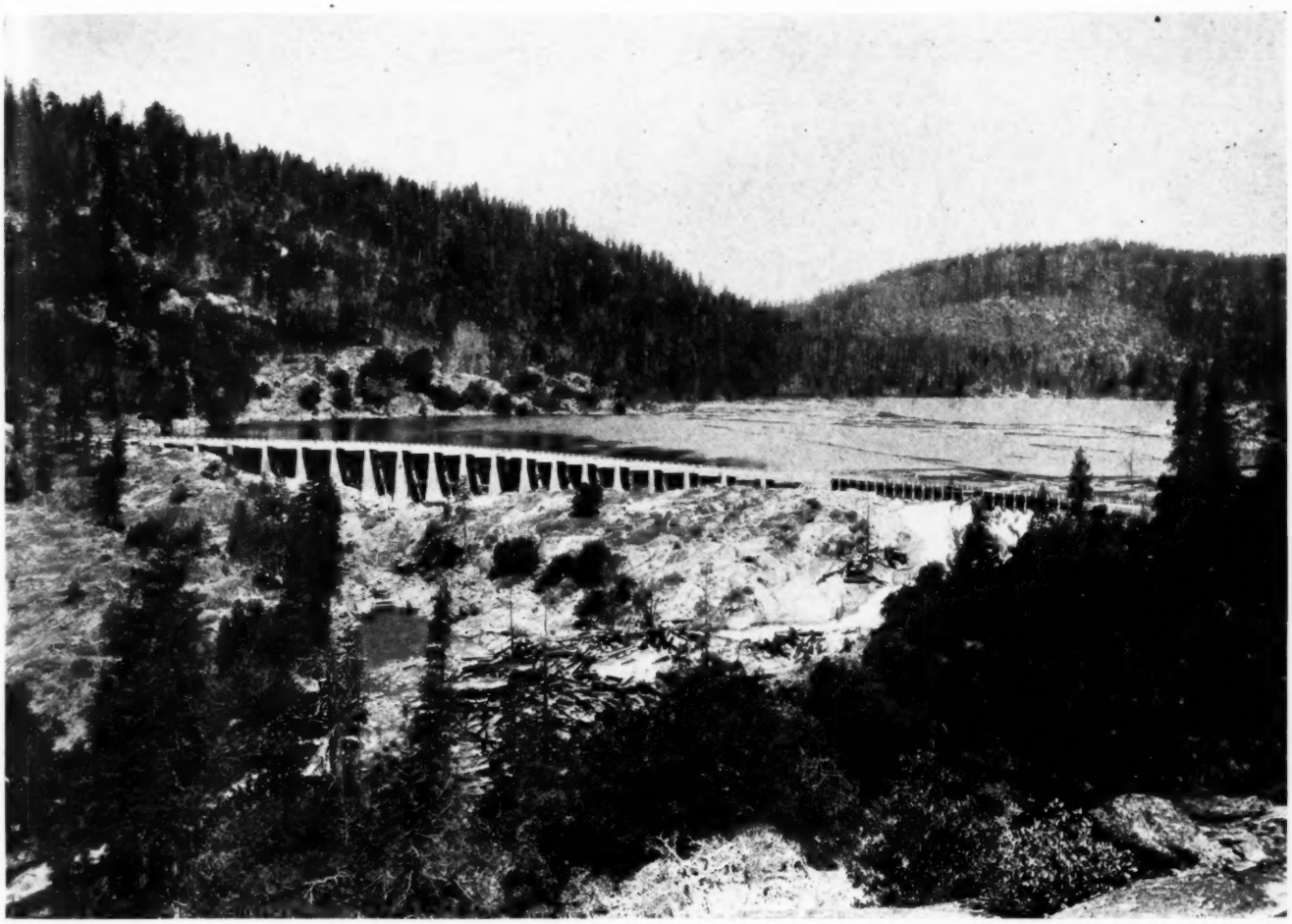
Water Works and Sewerage

Vol. LXXVII SEPTEMBER, 1930 No. 9



Lake Eleanor Dam of San Francisco Water Supply

The Hetch Hetchy Water and Power Project

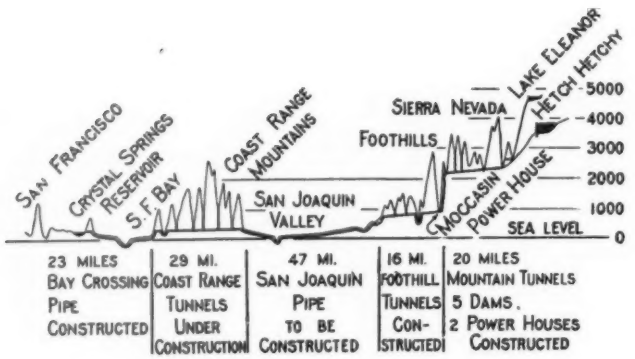
City of San Francisco Anticipates Completion by 1933—Driving and Lining of Coast Range Tunnel Expected to Be Completed in 1932—Work on Coast Range Tunnel Described—San Joaquin Valley Pipe Line to Be Begun in 1931—New Water Department Organized by City

By M. M. O'SHAUGHNESSY
City Engineer, San Francisco, Calif.

CONSTRUCTION is proceeding satisfactorily on San Francisco's mountain water and power project, on a schedule aiming at completion by 1933. The controlling schedule has been to construct the revenue-producing units as soon as possible and then to complete the aqueduct before the existing local water supply shall have become inadequate for the city's needs.

Working under this program the two ends of the system were completed first. The storage reservoirs at Hetch Hetchy and Lake Eleanor, with the Sierra Nevada tunnels and Moccasin power house are producing hydro-electric energy which is distributed in the city through the agency of a public service corporation to net the water project $2,000,000 annually. The Bay Crossing pipe line has been in use on a rental basis, carrying water from the East Bay sources of the Spring Valley Water Co. to the reservoirs on the San Francisco Peninsula. While operation of these producing units has been carried on, construction of the three remaining divisions of the aqueduct has been pushed.

The Foothill tunnel, 15.8 miles in length, from Moccasin power house to the San Joaquin valley, was completed in 1929. This tunnel consists of about 8¼ miles of 10-ft. 3-in. concrete-lined section and about 7.5 miles of 13-ft. 4-in. by 14-ft. 3-in. unlined, arch-top section.



Status of Hetch Hetchy Water Supply, 1930

The constancy of volume of flow in the aqueduct is disturbed by the varying load in the Moccasin power house, so re-regulation of the flow is necessary after leaving the tailrace. A re-regulating reservoir was provided by building a dam (the sixth on the project) across Moccasin Creek. This structure, completed early in 1930, is of rolled earth and rock fill with concrete core wall and rubble upstream face. The dam is 850 ft. long and 51 ft. high with crest at El. 927, and contains 143,000 cu. yd. of fill and 3,600 cu. yd. of concrete. It forms a reservoir of 648 acre-feet capacity, from which the water enters the tunnel.

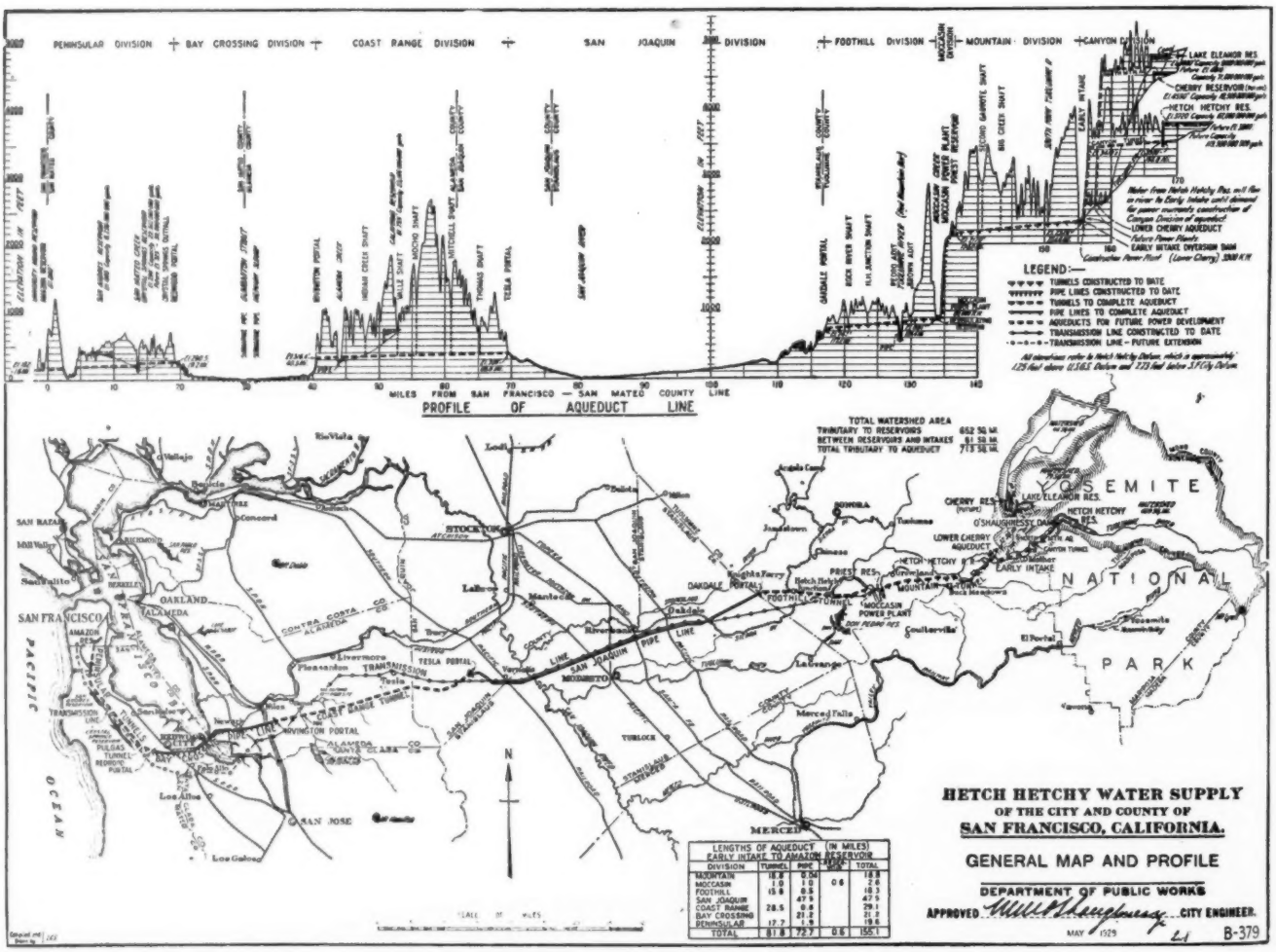
At Red Mountain Bar, 5 miles from Moccasin, the aqueduct crosses under Don Pedro reservoir in the canyon of Tuolumne River as riveted steel pipe 9 ft. 6 in. in diameter, laid in trench blasted out of the hard bedrock. The pipe is lined inside with cement mortar and is covered with an envelope of concrete from 18 in. to 2 ft. thick.

At this point the city contemplates erecting another power house. This plant, for an investment of $1,000,000, could produce power valued at $500,000 annually.

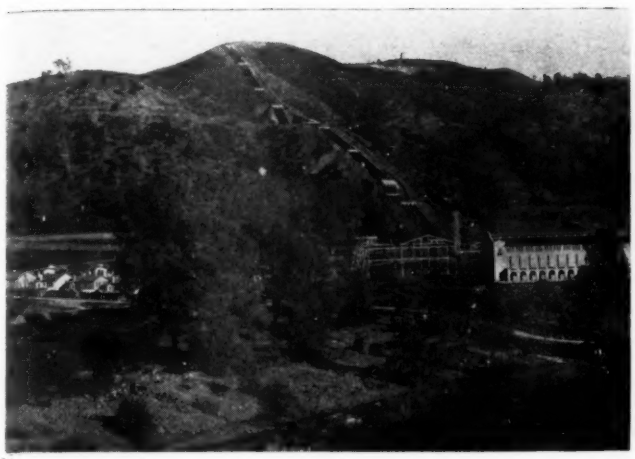
From the end of the Foothill tunnel, there will be a 47-mile pipe line across the San Joaquin valley. The pipe will follow along the city's present power transmission line in a 110-ft. strip already acquired. Bids for this pipe work will be taken early in 1931 so as to complete the work at the same time as the tunnel through the Coast Range, which is now under construction.

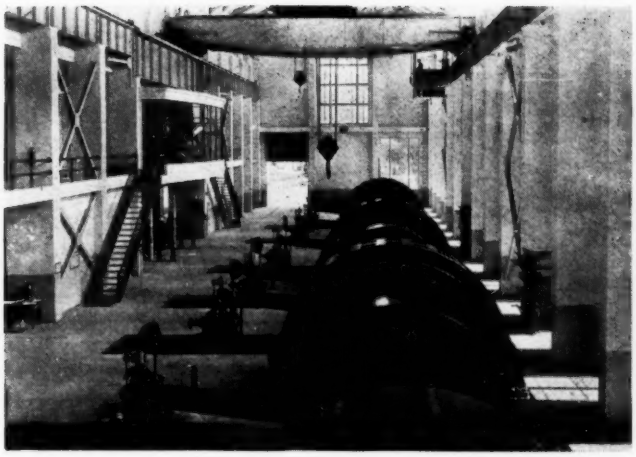
The aqueduct pierces the Coast Range, of which Mt. Hamilton and Mt. Diablo are prominent peaks, as a tunnel 28.6 miles in length. The easterly portal of this tunnel is the terminus of the San Joaquin pipe line. The westerly portal will require 1.3 miles of pipe to connect it to the existing Bay Crossing pipe. The tunnel is continuous for 25 miles to Sunol valley, which will be crossed by 0.6 miles of pipe.

In the 25-mile section of Coast Range tunnel, five construction shafts were sunk, two of which are over 800 ft. in depth. The tunnel is driven from four portals and both east and west from each shaft, or in 14 headings. At present 1,200 men are employed on this division and progress of almost 1 mile per month is being made. It is expected that the driving and lining will be completed in 1932, along with the pipe


PENINSULAR DIVISION
BAY CROSSING DIVISION
COAST RANGE DIVISION
SAN JOAQUIN DIVISION
FOOTHILL DIVISION
MOUNTAIN DIVISION
CANYON DIVISION
PROFILE OF AQUEDUCT LINE
LEGEND:
TUNNELS CONSTRUCTED TO DATE
PIPE LINES CONSTRUCTED TO DATE
TUNNELS TO COMPLETE AQUEDUCT
PIPE LINES TO COMPLETE AQUEDUCT
AQUEDUCTS FOR FUTURE POWER DEVELOPMENT
TRANSMISSION LINE CONSTRUCTED TO DATE
TRANSMISSION LINE - FUTURE EXTENSION
TOTAL WATERSHED AREA TRIBUTARY TO RESERVOIRS 652 SQ. MI.
BETWEEN RESERVOIRS AND INTAKES 61 SQ. MI.
TOTAL TRIBUTARY TO AQUEDUCT 713 SQ. MI.
YOSEMITE NATIONAL PARK
HETCH HETCHY WATER SUPPLY
OF THE CITY AND COUNTY OF
SAN FRANCISCO, CALIFORNIA.
GENERAL MAP AND PROFILE
DEPARTMENT OF PUBLIC WORKS
APPROVED ... CITY ENGINEER.
MAY 1929
B-379
LENGTHS OF AQUEDUCT (IN MILES) EARLY INTAKE TO AMAZON RESERVOIR
DIVISION | TUNNEL | PIPE | OPEN | TOTAL
MORYAN 18.8 0.54 19.3
MOCCASIN 1.0 1.0 0.6 2.6
FOOTHILL 15.8 0.5 16.3
SAN JOAQUIN 47.5 47.5
COAST RANGE 28.5 0.6 29.1
BAY CROSSING 21.5 21.5
PENINSULAR 17.7 0.5 18.2
TOTAL 81.8 72.7 0.6 155.1

General Map and Profile, Hetch Hetchy Water Supply





Left—Moccasion Power Plant. Right—Interior of Power House. Head, 1,316 Ft.; Total Capacity, 100,000 Hp.; Four Generators with Double Overhung Pelton Wheels

construction noted above, so that the entire aqueduct will be ready to conduct the pure mountain water by Jan. 1, 1933, to fill the peninsular storage reservoirs recently acquired by the city from the Spring Valley Water Co.

Although the tunnels previously constructed have been built to a capacity in excess of 620 sec.-ft., or 400 m.g.d., economic studies indicated the advisability of building this tunnel on the installment plan. The present 10-ft. 6-in. diameter tunnel, on a flatter grade than the previous tunnels, will have a capacity of about 300 m.g.d., which will be sufficient for many years. A future parallel tunnel of equal capacity may be constructed when necessary. The compounded saving in cost of the present smaller tunnel as against a present full-capacity tunnel is estimated at $8,000,000 or greater.

The shafts sunk are on the center-line of the double aqueduct. The long axis of each shaft, which is 6 ft. 9 in. by 20 ft. (overall dimensions) is at right angles to the aqueduct center. Parallel to the axis a crosscut, generally 14 ft. in clear diameter, is driven 95 ft. north to the center-line of the present tunnel and 90 ft. south to the future tunnel. Short stub ends of the future tunnel serve for car storage, electrical equipment, etc. Pumps are installed in the crosscut. Shaft and crosscut are lined with concrete to permit their use for construction of the future tunnel.

Excavation is by the usual methods, either drilling and blasting, or by air spades if the material is soft. The spoil is loaded by air-operated mucking machines into steel cars which are hauled by storage-battery locomotives. The muck is hoisted from the shaft rock pockets and automatically dumped at the surface.

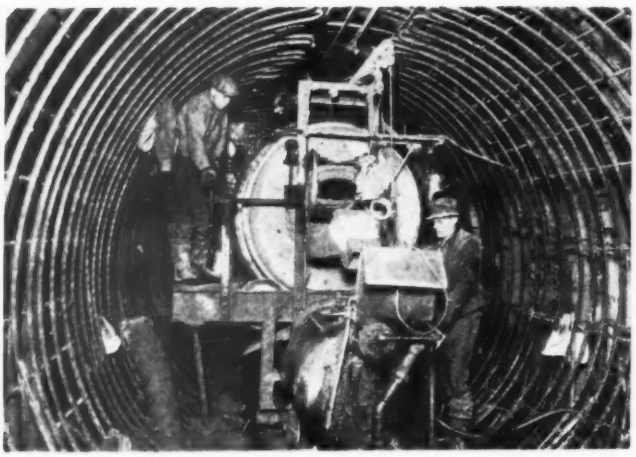
Lining will be placed by concrete gun. Gravel and sand will be obtained from nearby supplies which are now being developed. In some parts of the tunnel, the existence of swelling ground has necessitated immediate placing of concrete lining to prevent air-slacking. Such emergency lining is placed by cement gun.

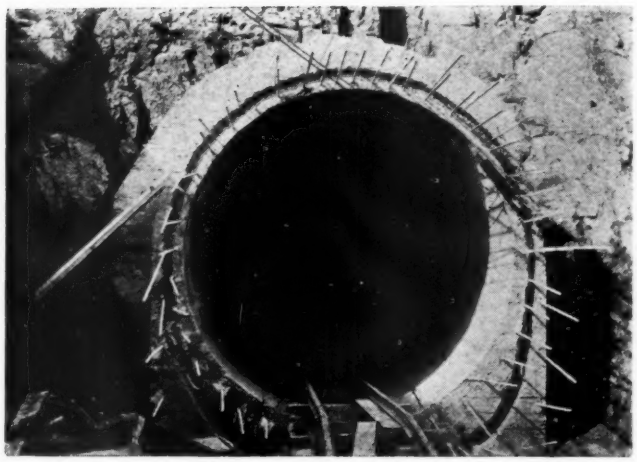
Occasional water-bearing seams are encountered. One of these, in sandstone, carried a flow of 2,500 g.p.m., which decreased to 1,000 g.p.m. Such seams are filled by grouting in the usual manner. The grouting operation is not difficult, but always causes considerable loss of time in carrying on the tunnel driving.

Fossiliferous and coal-bearing strata have been encountered and elaborate precautions have been taken to guard against explosion from pockets of methane and sulphuretted hydrogen gas. The present aqueduct location was selected after extensive geological studies and diamond-drill borings aggregating 5,014 ft. The abandoned Tesla coal mines, two miles north of the route gave indications of difficulties to be encountered as far as possible in view of the necessity of keeping the depths of shafts within a reasonable figure.

In over 28 miles the aqueduct deviates only ½ mile

Left—Interior of Priest Tunnel (Mountain Division). Right—Face of Priest Tunnel, 500 Ft. In.





Left—Pedro Adit, Foothill Tunnel; Concrete Mixer and Gun Place Concrete in 10-Ft. 3 In. Reinforced Circular Section. Right—Red Mountain Bar West Portal

from a straight line. The longest distance between shafts is 5.2 miles, which is justified by the city's experience in previous tunnel work.

Consideration was given to the practicability of an alternative route over the summit with a 60-m.g.d. temporary pipe line and pumping stations, but economic studies indicated a preference for the pressure tunnel.

Local storage and distribution for the mountain water will be provided by the facilities of the system of the Spring Valley Water Co., which was recently acquired by the city, the operation of which is vested in the newly created water department. The acquisition, on March 3, 1930, of this property brings the city 62,000 acres of watershed and reservoir lands, five impounding reservoirs with capacity aggregating 65 billion gallons, a well system and infiltration gallery, 111 miles of main aqueduct with several pumping stations, a distribution system of 20 reservoirs and tanks with 750 miles of pipe and pumping stations delivering water up to 800 ft. elevation, all riparian and other rights necessary to impound and divert the waters and over 105,000 consumers.

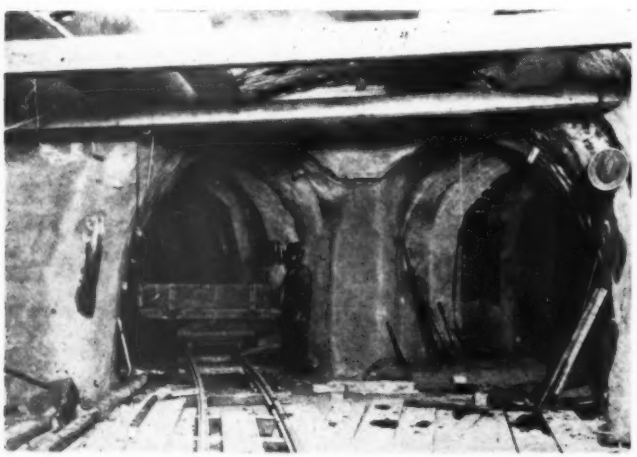
The local system has been estimated as sufficient to yield 65 m.g.d. or greater, but during a succession of seven or eight seasons of scant rainfall, it has been stressed to supply the needs of the city, which now amount to 52 m.g.d. As a means of temporary relief until completion of the Hetch Hetchy aqueduct, the city is sinking 20 wells in the sandy area adjacent to the ocean beach, in the expectation of producing 6 m.g.d.

The purchase of the local system on March 3, 1930, cost the city $40,000,000. The Hetch Hetchy system, when completed within three years, will have cost nearly $80,000,000. By capitalizing the $2,000,000 net annual power income, this latter figure may well be divided into $40,000,000 for water construction and a like amount for power construction.

Design and construction of the Hetch Hetchy project are under M. M. O'Shaughnessy, city engineer, with L. T. McAfee as chief assistant and C. R. Rankin and L. A. McAtee as construction engineers. Former Chief Assistant Engineer N. A. Eckart is now manager of the new water department, in charge of operation of the local system.

•

Large Bronze Castings for New York Water Supply.—The largest single order for bronze castings placed since the World War has just been awarded the American Manganese Bronze Co. of Holmesburg, Philadelphia. The castings which are to be made of manganese bronze of the highest physical values obtainable total over one million pounds. They are to be used in connection with the new water supply for the City of New York.



Left—Crosscut from Indian Creek Shaft, Coast Range Tunnel. Right—Concrete and Steel Pipe Bridge 3,870 Ft. Long, Over Shallow Portion of San Francisco Bay at Dumbarton Strait. Flexible-Joint Cast-Iron Pipe Carries Line Under Navigable Channel

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor

Filtration Engineer, Bureau of Engineering, Chicago, Ill.

The Taste Problem Solved

THREE years ago had some one predicted that the taste problem would be solved within three years most of us would have thought it impossible. Yet this is what has taken place within that time. Such rapid advances have been made in the development of treatments for the elimination of taste from water that within the very near future there should be no excuse for any water plant, except in very unusual cases, delivering water to the public with an objectionable taste. Taste as used in this article is intended to include both tastes and odors.

The perfection of methods for the elimination of taste from water constitutes the greatest advance made in water treatment since the introduction of filtration and chlorination. Nothing is going to produce greater confidence on the part of the public in the ability of the water chemists and engineers to treat water properly than the production of water free from taste. Just as we have confidence in the astronomer because he can calculate with exactness the time of an eclipse of the sun or moon, so will the public have greater faith in our work because we can produce palatable water. To say that the water is safe when it contains very disagreeable tastes, leaves doubt in the minds of most people. Many filtration plants have been greatly discredited because the water is not palatable all the time.

The following is from an editorial which appeared in one of the Chicago papers shortly after a modern filtration plant was put in operation in one of the nearby cities:

"————, a progressive city to the north of us, has made the experiment. Although only recently constructed, it is declared a failure so far as helping the taste. The city's million-and-a-half-dollar pumping station and filtration plant just opened and designed to produce better tasting water failed to do so.

"For more than twenty years ———— had argued about a filtration plant. The one just opened was hailed as the most modern and efficient in the middle west. It was constructed because ———— residents grumbled about paying increased water rents for unpalatable water.

"The water problem probably could be remedied by prohibiting the dumping of phenol wastes in the lake which would be much easier and cheaper than constructing useless filtration plants."

In so far as the clarity of the filtered water in this city was concerned, it was excellent, but the public wanted and expected water free from objectionable tastes and were not getting it. The number of filtration plant operators who, within the past summer, have sought the aid of the writer in their taste problem has been quite large. This indicates that many water supplies are below what they should be in palatableness, at least part of the time. The bottled water companies continue to flourish in a number of cities in which the water is filtered. Not long ago a representative of one of the large bottled water companies of the middle west was asked if he feared a loss of business in a certain city if filtration plants were constructed. He said no, that they had continued to do a large business in a near-by city which had filtered water, because the bottled water was more palatable than the filtered water.

We might attribute a small bottled water business in any city as being due to the peculiar ideas of some people, but a large business indicates that the bottled water is more palatable than the city water. Until the water purification chemists can produce water which is the equal in palatableness of bottled water, they should expect the bottled water companies to flourish. The water chemists have not remained idle, and the accomplishment within the past three years along this line speaks for itself. Early attempts to eliminate taste were along the lines of aeration and prevention of pollution, and it is only recently that the problem has made headway along chemical lines. Now let us see how it is being attacked and what is being accomplished.

It is believed that aeration, where the sole function is to throw off offensive gases into the air, may be eliminated from consideration. This is not to convey the impression that aeration has no value in water treatment, but as a taste elimination process it has been only moderately successful. That it is helpful in many instances, there is no doubt, but there are very few tastes that can be eliminated by this process to the extent that they cannot be detected, especially if the taste before aeration is very pronounced. Where water is deficient in dissolved oxygen it is evident that aeration is the cheapest means of restoring the oxygen; also it is evident if the water is high in carbon dioxide that it may be reduced materially by aeration.

Recent efforts in taste elimination have been along two lines. One is to prevent the taste being made more pronounced when chlorine is added to the water, and the other is to eliminate all objectionable tastes by removing them from the water or by changing them to inoffensive compounds. Where the chloro tastes are the only objectionable tastes, processes that prevent the formation of these compounds are satisfactory, but for a large number of waters the prevention of the chloro tastes only is not going to solve the taste problem.

The Superchlorination Treatment.—The addition of chlorine to water produces a strong oxidizing agent. Many of the taste-producing compounds can be broken down, or changed to inoffensive compounds by the nascent oxygen of the hypochlorous acid. With the small amount of chlorine usually added to water for sterilization, the concentration of residual chlorine is

not sufficient to bring about the oxidation of these offensive compounds. When enough chlorine is added to bring about the desired chemical reaction, considerable residual chlorine is left in the water and this will produce a disagreeable chlorine taste. There are several ways of dechlorinating water, which will be discussed later.

Sir Alexander Houston in his 1920 annual report on the London water supply pointed out the possibility of removing certain tastes by using an excess of chlorine. Brush[1] describes experiments made in January, 1922, on the use of an excess of chlorine to destroy the "ripe cucumber" or "fishy" taste in the Catskill water of the New York water supply caused by the presence of synura. About 0.70 p. p. m. of chlorine was used. The organisms decreased shortly afterwards, and there was no need for continuing it, but the treatment was regarded as a success. Howard[2] at Toronto was the first to make extensive use of the superchlorination treatment solely for the purpose of eliminating taste. Superchlorination followed by dechlorination with sulphur dioxide was first started at Toronto on Sept. 2, 1926. Howard reports the elimination of practically all taste by this treatment. The maximum dose of chlorine applied during the superchlorination treatment was 2.5 p. p. m., and the minimum dose, 0.8 p. p. m. Hale (*Water Works Engineering*, vol. 83, p. 1173, July 30, 1930) describes the successful use of superchlorination followed by dechlorination with sulphur dioxide to remove tastes caused by organic pollution of well water. Prechlorination is now being practiced at a number of filtration plants, and while enough chlorine probably is being added in a few instances to help in oxidizing the taste-producing compounds, in most instances enough is not being added to call the treatment a superchlorination treatment.

The success of the superchlorination treatment depends upon the power of the chlorine to break down the offensive compounds and also upon the effectiveness of the dechlorinating process. It so happens that the most commonly occurring tastes such as are produced by microörganisms and by the phenolic compounds are readily changed to inoffensive compounds when treated with a certain excess of chlorine. The water one hour after treatment should have from 0.5 to 1.5 p. p. m. of residual chlorine, depending upon the nature and the concentration of the taste-producing compounds. The taste in probably 95 per cent of the water supplies can be lessened or completely eliminated by the superchlorination treatment if the excess chlorine is later removed.

The addition of a strong oxidizing agent in excess to water has an advantage in that all bacterial life, regardless of how abundant, is killed and there can be no doubt as to the safety of the water. The oxidizable organic matter is reduced, and the water is more likely to remain stable when stored than if it contains a large amount of such matter. The main reason why superchlorination has not made greater headway has been the fear of the operator that he cannot at all times completely dechlorinate the water. Not that dechlorinating agents are ineffective at times, but the difficulty in securing an application of the dechlorinating agent in proportion to the residual chlorine present, when the residual is known to vary with fluctuating conditions of the water with constant application, has made many operators hesitate to try this treatment.

Dechlorination with Sulphur Dioxide.—Sulphur dioxide is a very effective dechlorinating agent. It is obtained as a liquid under pressure, and has to be handled in much the same manner as chlorine. The reaction is as follows:

$$SO_2 + H_2O = H_2SO_3$$
$$H_2SO_3 + OHCl = H_2SO_4 + HCl$$

Theoretically it requires about 0.9 lb. of sulphur dioxide to dechlorinate 1 lb. of residual chlorine. In practice it has been found best to add about the same amount of sulphur dioxide as the residual chlorine. Howard was the first to use sulphur dioxide for dechlorination on a large scale. In a paper presented before the Water Purification Division of the American Water Works Association at the St. Louis convention, June, 1930, on progress in the superchlorination treatment for taste prevention at Toronto, Howard regards the treatment as highly successful. He also describes the equipment necessary for handling the sulphur dioxide. In this same paper Howard stated that an occasional musty taste has occurred in the water following superchlorination, and that research work carried out at Rotterdam, Holland, showed that the addition of a chlorophenolic solution to river water produced a musty taste after filtration, which later was removed by passing the water over Norite activated carbon.

Dechlorination with Sodium Bisulphite.—This compound ($NaHSO_3$) may be purchased in the powdered form, and is readily soluble in water. Its dechlorinating properties depend upon the SO_2 present in the compound. The reaction is

$$2NaHSO_3 + 2OHCl = Na_2SO_4 + H_2SO_4 + 2HCl.$$

L. I. Birdsall, of the General Chemical Co., is believed to be the first to use this material for dechlorination, though its dechlorinating properties were well known. Its first use was at the Glencoe, Ill., filtration plant in July, 1930. It was used for dechlorinating the water that was superchlorinated to remove a fishy taste. About 1.5 lb. of sodium bisulphite are required to dechlorinate 1 lb. of residual chlorine.

The Chlorine-Activated Carbon Treatment.—Experimental work indicates that the chlorine-activated carbon treatment is the most successful of any of the treatments for the elimination of practically all objectionable tastes from water. It combines all the advantages of a strong oxidizing compound with material having the power to absorb most of the taste-producing compounds. So far, no taste likely to be present in water has been found that cannot be removed by this treatment. It will be only in very unusual cases that a taste will be found that cannot be removed.

The water is superchlorinated, preferably at the beginning of the treatment process, to the extent that there is a large excess of chlorine after filtration, or just before it is dechlorinated. Up to this point it is merely the superchlorination process. In most instances a residual of about 0.5 to 1.0 p. p. m. of chlorine just prior to dechlorination will be sufficient, especially if there has been 3 to 4 hours' contact time. For some waters a residual greater than 1.0 p. p. m. may be required, but very likely no condition will require a residual greater than 2.0 p. p. m. Now these figures may astound some of the filtration plant operators who have been accustomed to working with residual chlorine figures ranging from 0.00 to 0.20, and under instruction not to let the residual exceed 0.20 for fear of producing a chlorine taste. No doubt they will at first fear that so great an increase over their usual dosage will occasionally produce taste due to some mishap in the treatment process. The effectiveness of the dechlorinating process is one of the chief merits of the

chlorine-activated carbon method. It is almost a foolproof installation, and can be made to work about as effectively in a small plant where there is no technical supervision as in a large plant where there is the best of supervision. About all that is required of the operator is to know how to make residual chlorine tests.

The fact that charcoal, lignite, activated carbon, etc., will dechlorinate water has been known for a number of years. The Candy Filter Co., of England, made use of this process about 20 years ago[3]. They probably used an active carbon at first and later changed to raw lignite, for we find that Frank Candy and Frank Pullen Candy applied for a British patent July 23, 1915, on the use of raw lignite. Patent No. 10,705 was granted July 20, 1916. The following from the specifications in the patent may be of interest in view of the fact that more recent patents have been issued on the use of activated carbon for dechlorination:

> In carrying our invention into effect we first add to the water a bacterial dose of free or available chlorine (which we will speak of as "free chlorine") and, after allowing sufficient time for the due action of the free chlorine upon the bacterial impurities of the water, we bring the same, still containing free chlorine, in contact with lignite, preferably by passing the chlorinated water through a bed containing granulated lignite; we have discovered that the lignite possesses remarkable properties in eliminating or fixing the free chlorine and is much more effective for this purpose than carbonized lignite which we have previously used.
>
> The quantity of free chlorine we generally employ, for drinking water of an average chemical purity, is one part to one million parts of water and the thickness of the layer of lignite we use when passing the treated water through it at the rate of about 150 gal. to each square foot of filtered bed area per hour is about 18 in. We granulate and sift the lignite to produce fragments of suitable size for our purpose.
>
> We preferably place a layer of sand under the layer of lignite and arrange the whole so as to give free drainage or passage of the water therefrom.
>
> We generally allow a period of about half an hour for contact between the free chlorine and the water before subjecting the same to the dechlorinating action of lignite.

This should be of particular interest as it is almost the same as is used today, except that activated carbon is preferred to the raw lignite due to its high adsorbtive properties. Also it has been found that for most waters a higher dose of chlorine is desirable, and that deeper beds of carbon are better. This patent refers to the previous use of carbonized lignite, which indicates that active carbon was used prior to the raw lignite.

Just why the Candy inventions did not attract more attention at that time probably was due largely to the fact that filtration engineers and chemists were not willing to admit, or did not know, that chlorine had a value other than a sterilizing agent, and they were striving to keep its use down to a minimum by making filtration as effective as possible. Candy apparently abandoned the use of an adsorbing carbon for material that merely dechlorinated the water, and while it dechlorinated the water all right it probably was not very successful for taste elimination under the conditions in which it was used. Had a little more study and experimentation been given to the use of active carbons in water treatment at that time we might have been much more advanced in taste elimination than we are today. The prevailing opinion 15 to 20 years ago was that if a little chlorine produced a disagreeable taste a larger amount would make the taste still more pronounced. In fact our attention was focused on the sterilization of water at that time and little thought was given to taste removal.

About the time filtration chemists and engineers were becoming fully convinced that some effort must be made to reduce the objectionable tastes that occurred in many waters to meet the demands of the public for more palatable drinking water, and began to study taste elimination methods, the experiment on activated carbon was started at Cleveland. The report of the Cleveland work at this writing has not been made public, but according to rumors the carbon was not a success. This has done a great deal to discourage the use of activated carbon. If the experiments were not a success it must have been due to the kind of material used or the manner in which they were conducted, for the right kind of material undoubtedly would have been a success if tried along conservative lines.

A publication of the essential facts of the Cleveland report would do much to clarify the situation, for very likely there would be no difficulty in showing wherein the materials or the procedure was at fault, if the report shows carbon to be a failure as the rumor is circulated. Sometimes we find considerable difference between rumors and the actual facts. This should not be construed as criticizing the taste prevention treatment which has been adopted at Cleveland. If the ammonia-chlorine treatment completely eliminates all tastes at Cleveland and produces the ideal tasting water, then there can be no criticism of this treatment being adopted.

Rapid progress in an experimental way is being made on the use of activated carbon in water treatment. Suitable types of carbons have been developed, and the requirements for their successful use have been worked out fairly well. Recent publications both in Germany and the United States give considerable information on the subject. Imhoff and Sierp[4] describe successful experiments on the elimination of taste, first with an experimental unit containing 20 liters of activated carbon; then on a plant scale for treating 25,000 cubic meters (about 6,600,000) gal. of water daily, where the taste trouble has been prevalent for years. The treatment in addition to removing the phenols has also removed earthy, musty odors from the water. This article was translated by Dr. Buswell, and published in the August, 1929, issue of *Public Works*, pp. 308-309. Sierp[5] gives a summary of the literature on the cause and prevention of smell and taste in drinking water, and states that a large amount of chlorine, given a long contact time and then removed, leaves no taste. Sodium thiosulphate or sulphur dioxide will remove the chlorine. An active carbon filter is sufficient without excess chlorination. It has been found to remove not only chlorophenol taste, but other tastes arising from algae or mineral matter.

Adler[6] adds a large amount of chlorine to the water and then passes the water over activated carbon to convert the chlorine to hydrochloric acid. From time to time the carbon must be washed with water containing sodium carbonate to remove the organic material from the surface. Jotten, Sartorius and Ottemeyer[7] state that charcoal is well adapted to the removal of taste, turbidity, etc. They found that activated charcoal was much better for removing phenol than wood charcoal or coke. Koenig[8] conducted experiments to find the best means of treating the Elbe water for Magdeburg. Chlorination of the raw water showed advantages in algae destruction, decrease in bacterial growths and longer filter runs, but odor and taste were not removed. Activated carbon, alum and marble calcium hydroxide were added in this order before the primary filters. The adsorbtive effect of the carbon was impaired by the formation of a coating of aluminum hydroxide. The most satisfactory results were obtained by treating the water before the primary

filters with filter alum and fuller's earth with subsequent activated carbon filtration. The final effluent was free from color, taste and odor.

In the year book for water chemists and sanitary engineers, Vol. 3, Verlag Chemie G. M. B. H. Berlin W 10., R. Engler gives an account of the operating experiences at the experimental Stuttgart water works in purification of surface water containing humic acid. Taste was removed with active carbon. In the same publication, H. Pick describes the dechlorination of water with active carbon. Dechlorination follows the equation of mono-molecular reactions. Regeneration was accomplished with a solution of 5 per cent sodium hydroxide, but it is better to heat to 200 to 500 deg. C.

The writer[9] presented a paper before the Water Purification Division of the American Water Works Association at the Toronto convention in June, 1929, on the activated carbons and their use in removing objectionable tastes and odors from water. The work on activated carbons at the Chicago experimental filtration plant was described. A unit having 10 sq. ft. of surface area and 24 in. of 4 to 12-mesh Hydrodarco is being run at a rate of 2 gal. per sq. ft. per minute. Spalding[10] describes the successful use of pulverized Nuchar by adding it to the water and later removing by filtration. The taste was removed by this procedure. He also describes the removal of taste caused by aldehol contamination, which was not removed entirely by superchlorination.

Behrman and Crane presented an excellent paper before the Water Purification Division of the American Water Works Association at the St. Louis convention in June, 1930, on the chemical and mechanical utilization of activated carbon in water treatment. They gave a description of units suitable for passing water through beds of Hydrodarco as manufactured by the International Filter Co., and many other details regarding the practical utilization of carbon. At this same meeting, George D. Norcom gave results of an interesting series of experiments conducted with carbon on the water supply for Chester, Pa. This paper was published in WATER WORKS AND SEWERAGE, August, 1930, p. 269. The water is polluted by a variety of industrial wastes. Hydrodarco removed all the tastes and odors from the water for the duration of the experiments, which lasted several months. Passing steam through the carbon partially revivified it. Also at this meeting the writer brought his experiments at Chicago up to date. The carbon unit started in December, 1928, is still giving satisfactory service.

Thus we can see that there has been sufficient experimentation on the superchlorination treatment combined with dechlorination with activated carbon to give the promise of extensive use of the process in the future. There can be no question as to the effectiveness of the chlorine-activated carbon treatment in practically all waters. The only question is whether a cheaper and equally effective treatment may be found. To give details on the practical application of carbon in water treatment would make the present article too long. Apparently the only disadvantage is the first cost. There are indications that it will add 5 to 10 per cent to the plant cost for new treatment plants and somewhat more for plants already constructed.

The cost of the carbon should be charged to operating expenses, but the units have to be filled with carbon at the start. With fairly good water that has only an occasional taste, the cost of eliminating the taste should not exceed $1 per m. g., and for highly polluted water the cost will vary from about $1.50 to about $3.00 per m. g. The cost of the carbon, the cost of revivification and the number of times it has to be revivified will have considerable influence on the cost of the treatment. The carbon used for color removal in sugar refineries is revivified many times before it has to be discarded, giving indication that this may also be the case in water treatment. The writer is of the opinion that it is economy to do as much of the taste elimination as possible with chlorine, and use the carbon for removing the excess chlorine and compounds not broken down by the chlorine. The reaction of the chlorine with the carbon is a direct chemical action and there is no necessity for frequent revivification.

Adsorption by Activated Carbon.—The use of activated carbon as above described is in connection with chlorine, and allows the chlorine to do all it will towards breaking down the taste-producing compounds before the water reaches the carbon. The carbon then removes by adsorption such offensive compounds as are not changed by the chlorine, and also the residual chlorine. Experiments on the use of activated carbon without the use of chlorine indicate that most, if not all the taste-producing compounds, may be removed by adsorption. The literature on the characteristics of the activated carbons and their use in the industries is quite extensive. We are more familiar with their use in gas masks during the world war, and their use in the sugar industry. The reader is referred to articles by Strachan[11], Chaney, Ray and St. John[12], Bartell and Miller[13], Miller[14], Horton[15], Lamb, Wilson and Chaney[16], and Mantell[17].

The number of compounds that may be removed from water by adsorption with activated carbon is fairly large. No one has attempted to determine all the compounds, but it seems that practically all taste-producing compounds that are likely to occur in water may be removed in this manner. Adsorption may be distinguished from a direct chemical reaction in that the surface carbon atoms do not turn loose their bond with the interior atoms of the carbon, but remain fixed and attract the adsorbed substances to the surface of the carbon with sufficient force to hold them on the surface. The effectiveness of a material is dependent upon its carbon content, the surface area and perhaps other characteristics not so well understood. While its use in water treatment is largely in the granular form, the granules themselves must be very porous and have an enormous surface area for a given volume of the material. The surface area of a 1-in. solid cube is 6 sq. in., whereas the surface area of a porous substance such as an activated carbon may be several million square inches for each cubic inch of the material. This is why it is essential to keep the pores of the granules of carbon open. Anything that stops up the pores greatly reduces the adsorptive capacity of the carbon.

Kolthoff and Van Der Goot[18] have made probably the most extensive study of the hydroxybenzenes and other aromatic compounds that are adsorbed by carbon. They give the values for $\frac{1}{n}$ and $\propto$ in the Freundlich adsorption equation $\frac{x}{m} = \propto C_2^{\frac{1}{n}}$ for a number of such compounds, using "carbo merk" for the active carbon. The fraction $\frac{x}{m}$ represents the millimoles of the com-

pound adsorbed by 1 gram of air dry carbon. $\frac{1}{n}$ and α are constants that have to be determined for each material adsorbed and for each brand of carbon. C_2 is the concentration of the material in moles remaining in solution. Table I gives the values of these constants as determined by Kolthoff and Van Der Goot.

We do not have much information at the present time as to how often activated carbon will have to be revivified when used without chlorine. There are indications that it will have to be more frequently than when used in connection with chlorine, for the chlorine seems to help keep the material active.

It might be well to call attention to the fact that the constants in Table I were determined from results recorded in moles or millimoles of the compound adsorbed and remaining in solution. The writer's results as given in a previous article were recorded in parts per million and parts per billion. For those who are not so familiar with chemical terms, it might be well to state that all compounds given in the list are readily adsorbed by activated carbon. The table does not give the entire list of taste-producing compounds that may be present in water. In so far as the writer knows, the compounds responsible for algae or fishy taste in water are not known.

All carbons that dechlorinate do not have high adsorptive properties. Table II shows comparison of the phenol adsorptive capacity of raw and carbonized lignite. The carbonized lignite used in the test was Hydrodarco, a material that is treated especially to make it highly adsorptive.

Assume that not more than one part per billion of phenol can remain in solution without causing chlorophenol tastes when chlorine is added, the raw lignite reduced to this figure a solution containing about 30 parts per billion of phenol whereas the Hydrodarco reduced to the same figure a solution containing 5,000 parts per billion of phenol. This shows the activated material to have an adsorptive capacity approximately 166 times that of raw material. The raw material dechlorinates very well but that is about all that can be said in its favor.

The Ammonia-Chlorine Treatment.—A taste elimination treatment now being promoted very actively is the addition of ammonia to the water prior to chlorine. The main function of this treatment is to prevent the formation of chloro tastes. The chlorine unites with the ammonia to form a chloramine which is a weak instead of a strong oxidizing agent. This compound does not readily oxidize the organic matter present in the water, which is directly opposite to the purpose of the superchlorination treatment, for the superchlorination treatment is applied to oxidize as much of the organic matter as possible. Some of the advantages of the ammonia-chlorine treatment, as summarized by J. F. T. Berliner in a publication of the National Ammonia Co., are as follows:

Chloramine is a much more effective bactericide than chlorine.

It retards or completely prevents aftergrowth formation in treated water.

The chloramine treatment of water eliminates objectionable odors and tastes such as chlorophenol tastes, chlorinous odors and tastes, etc.

It allows a reduction of about 50 per cent or more of the amount of chlorine required for actual sterilization.

The oxidizing action of chlorine is retarded and its absorption prevented, thus allowing practically the total quantity of chlorine to be available for germicidal action.

Chlorine residuals sufficient to overcome sudden increase of bacterial load are feasible when chloramine is employed, both because the taste is controlled and because the solution maintains a sterilizing power for much longer periods than is possible for a chlorine solution.

Berliner states that the only apparent disadvantage of chloramine is that it requires a greater length of time to sterilize the water than with chlorine.

That the ammonia-chlorine treatment will be used extensively seems very probable. There are a number of water supplies not greatly polluted and where the chloro tastes are all the objectionable tastes that are of any consequence. In such waters it is likely that the chloramine treatment will be sufficient. Also there are a number of water supplies where it is desirable to maintain a residual chlorine throughout the distribution system, and to do so with chlorine alone requires the addition of an amount that causes a chlorinous taste. It seems that chloramine should be particularly adapted to such conditions.

There is no doubt that ammonia prevents the formation of chloro tastes such as chlorophenols. There also is evidence that, where any taste is made more pronounced by the addition of chlorine, ammonia will pre-

TABLE I—VALUES FOR $\frac{1}{n}$ AND α IN THE FREUNDLICH ADSORPTION EQUATION AS DETERMINED BY KOLTHOFF AND VAN DER GOOT

Material	$\frac{1}{n}$	α
Phenol	0.15	5.7
Aniline	0.15	6.61
Monomethyl aniline	0.125	6.46
Dimethyl aniline	0.165	8.22
o-Cresol	0.52	19.5
Resorcinol	0.09	3.6
Hydroquinol	0.09	3.8
Catichol	0.07	3.55
Pyrogallol	0.06	3.1
Phloroglucinol	0.06	2.37
Paranitrophenol	0.075	5.05
Gallic acid	0.145	4.0
Pyridine	0.205	5.0
Antipyrine	0.20	3.6
Picric acid	0.46	21.4
Benzoic acid	0.18	11 5
Salicyclic acid	0.12	8.7
Sulfosalicylic acid	0.06	4.7
Benzenesulfonic acid	0.20	2.9

TABLE II—COMPARISON OF PHENOL ADSORPTION WITH LIGNITE BEFORE AND AFTER ACTIVATION

One-gram samples of the materials pulverized to pass a 200-mesh sieve were placed in 1-liter portions of water containing various amounts of phenol and agitated 4 hours; the clear solution was tested for phenol.

Phenol Added, Parts per Billion	Residual Phenol in Parts per Billion	
	Raw Lignite	Hydrodarco
25	0.0 Tr	0.0
50	4.0	0.0
100	18.4	0.0
300	52.8	0.0
500	154.0	0.0
1,000		0.0
2,500		0.0
3,000		0.0
4,000		0.0
4,500		0.0
5,000		0.7
7,500		12.0
10,000		40.0
12,500		108.0
15,000		223.0

vent the taste being made more pronounced. The writer has met a few who are so enthusiastic over the treatment that they believe tastes of all kinds can be eliminated, even tastes originally present in the water such as algae tastes.

The literature on the ammonia-chlorine treatment is increasing rapidly. Berliner states that for all practical purposes we may consider that the chlorine reacts with the ammonia to form monochloramine (NH_2Cl), and that this probably slowly decomposes into nitrogen and hydrochloric acid. He also states that chloramine is known to have three to six times the bacterial efficiency of chlorine, and that there is no completely satisfactory explanation for this. It is not the purpose of this article to discuss the sterilizing value of chloramine, which appears to be its chief advantage, but to discuss its use in taste elimination or prevention.

Harold[19], Houston[20] and Adams[21] were among the first to note the prevention of certain tastes by means of chloramine. McAmis[22] at Greensville, Tenn., was the first to use ammonia on a plant scale in the United States for taste prevention. Harrison[23] was not very successful in preventing taste at Bay City, Mich., with ammonia. Spaulding[24] reports good success at Springfield, Ill. Braidech[25] states that the value of preammoniation is definitely established as a means of prevention rather than destruction of the phenolic and chlorinous odors and tastes. Tastes and odors are effectively prevented in as high a concentration as 1 p.p.m. of phenol. Cox[26] states that the chlorophenol tastes of raw Lake Erie water at Buffalo were eliminated by preammoniation. Ellms and Ruth presented excellent papers on the use of ammonia with chlorine at the St. Louis convention of the American Water Works association (see WATER WORKS AND SEWERAGE, August, 1930, p. 277). They praised the ammonia treatment very highly for the elimination of tastes. Klein and Brown[27] did not get complete removal of taste at Mamaroneck, N. Y., with ammonia, though there was some reduction. From these favorable accounts of the use of ammonia it is evident that it will be used quite extensively.

The Potassium Permanganate Treatment.—Potassium permanganate is a strong oxidizing compound, and should be effective in eliminating such taste-producing compounds as may be oxidized. The writer knows very little about the treatment, but has heard favorable comments where it has been used. Cox[26] states that "The trial of potassium permanganate treatment at Rochester and Lackawanna, N. Y., was recommended by the New York State Department of Health in the hope that this very flexible treatment would prove efficacious. The satisfactory results secured at these two points leds the department to recommend that similar treatment be utilized at Buffalo, Rensselaer and Waterloo during 1929, when cholorophenol tastes were occurring in these supplies." Cox then states that the treatment was not universally satisfactory, and while it destroyed the chlorophenol taste, slight bitter and astringent tastes were occasionally noted at Buffalo, Waterloo and Rensselaer. About all that may be said in favor of the potassium permanganate treatment is that it is suitable for a few water supplies.

Ozone.—The writer has had no experience with ozone. It is a strong oxidizing compound and should be fairly effective in taste prevention. Certainly chloro tastes are not produced. It has not made much progress in water treatment in the United States, probably due more to the cost than anything else. With a greater demand for more palatable water, ozone may have a limited use in municipal supplies.

The Future of Taste Elimination.—That there is going to be a stampede to try the ammonia-chlorine treatment with the hope that it will at least give partial relief seems evident. Due to the effective sales organizations of the producers of ammonia and manufacturers of machines for handling ammonia, practically every water purification chemist, engineer and water superintendent will soon be informed of the advantages of the ammonia-chlorine treatment. The fact that it can be tried with little expense is greatly in its favor. In plants where it reduces the taste to a satisfactory point its use likely will be continued indefinitely.

The superchlorination treatment followed by dechlorination with sulfur dioxide, or similar compounds, will likely come into fairly extensive use. This will thoroughly establish the advantages of using a strong oxidizing compound. Then the superchlorination treatment followed by dechlorination with activated carbon will gradually become more extensive. Carbon will likely prove to be the cheapest dechlorinating substance, as well as having the advantage of adsorbing tastes not removed by any of the other treatments. It also is particularly adapted to small installations where it is difficult to dechlorinate effectively with another chemical due to the difficulty in applying the dechlorinating compound uniformly in proportion to the residual chlorine present.

Table III is a comparison of several methods of taste elimination or prevention. For some taste-producing compounds such as phenols one has a choice of most any treatment. The chlorine-activated carbon seems to be the only one adapted to most any taste, though the superchlorination treatment alone is not far behind.

TABLE III—COMPARISON OF TASTE ELIMINATION PROCESS

Taste	Superchlorination Followed by Dechlorination with Sulphur Dioxide, etc.	Superchlorination Followed by Dechlorination with Activated Carbon	Ammonia-Chlorine	Potassium Permanganate
Chloro	Eliminated	Eliminated	Prevented	Prevented
Algae	Destroyed	Destroyed	*No change	No information
Fishy	Destroyed	Destroyed	*No change	No information
Chloropheno	Destroyed	Destroyed	Prevented	Destroyed
Oil wastes	No change	Adsorbed	*No change	No information
Decaying vegetation	Largely eliminated	Eliminated	*No change	No information
Earthy	No information	Removed	*No change	No information
Musty	Not removed	Adsorbed	*No change	No information
Humic acid	No information	Removed	*No change	No information
Hydrogen sulphide	Removed	Removed	No information	No information
Aldehol	Partially destroyed	Adsorbed	Probably prevented	No information

* The addition of chlorine usually makes the taste more prouonced, and the increase in taste is prevented by the use of ammonia. There is no evidence that the taste originally present is actually reduced as a result of the addition of ammonia. Most tastes occurring naturally in water are reduced by the filtration process, and this leads some to believe that the ammonia is responsible.

REFERENCES

[1] Brush, W. W. Synura and Other Organisms in the Catskill Water Supply. Engineering News-Record, 88: No. 7, 266-71, Feb. 16, 1922.

[2] Howard, N. J. Modern Practice in the Removal of Taste and Odor. J. Am. Water Works Assoc. 9: 766-82, Sept., 1922.

Howard, N. J., and Thompson, R. E. Chlorine Studies and Some Observations on Taste-Producing Substances in Water, and the Factors Involved in Treatment by Super- and Dechlorination Method. J. New Eng. Water Works Assoc., 40: No. 3, 276-96, 1926. Discussion, 41: No. 1, 59-62, 1927.

Howard, N. J. Progress in Superchlorination Treatment for Taste Prevention at Toronto. Presented at the St. Louis convention, June, 1930. Water Works Engineering, 83: 1145, July 30, 1930.

[3] J. Royal Institute Pub. Health, 19:1, Jan., 1911.

[4] Imhoff, Karl, and Sierp, F. Filter aus Aktiver Kohle zur Verbesserung des Geschmacks von Gechlortem Trinkwasser. Sonderabdruck aus der Wochenschrift. Das Gas- und Wasserfach, 1929.

[5] Sierp, F. Improving the Smell and Taste of Drinking Water. Technischen Gemeindeblatt, 32: 11, 153 and 12, 165, 1929.

[6] Adler, Rudolph. Purification and Sterilization of Water by High Chlorination. Gass- u. Wasserfach, 72: 675-8, 1928.

[7] Jotten, K. W., Saratorius, Fr., and Ottenmeyer, W. The Removal of Troublesome Substances from Drinking Water by Means of Active and Inactive Charcoal. Gesundheits-Ingenieur, 52: 529-34, July 20, and 546-50, July 27, 1929.

[8] Koenig, O. Innovations in the Chemical Purification of Drinking Water and Information on the Present Application of Activated Carbon and Fuller's Earth. Gas- u. Wasserfach, 72: 1065-72 and 1091-1102, 1929.

[9] Baylis, John R. The Activated Carbons and Their Use in Removing Objectionable Tastes and Odors from Water. J. Am. Water Works Assoc., 21: 787-814, June, 1929.

[10] Spalding, George R. Activated Char as a Deodorant in Water Purification. J. Am. Water Works Assoc., 22: 646-8, May, 1930. Discussion, Water Works Engineering, 83: 1174, July 30, 1930.

[11] Strachen, J. T. Activated Carbon: Some Industrial Applications. Chem. and Ind., 47: 46, 1203-14, Nov. 16, 1928.

[12] Chaney, N. K., Ray, A. B., and St. John, A. Ind. and Eng. Chem., 15: 12, 1244-55, Dec., 1923.

[13] Bartell, F. E., and Miller, E. J. Adsorption by Activated Charcoal, I, J. Am. Chem. Soc., 44: 9, 1866-90, Sept., 1922. II, J. Am. Chem. Soc., 45: 5, 1106-16, May, 1923.

[14] Miller, E. J. Adsorption by Activated Sugar Charcoal. I, J. Am. Chem. Soc., 46: 5, 1150-58, May, 1924. II, J. Am. Chem. Soc., 47: 5, 1270-80, May, 1925. III, Adsorption from Solution by Ash-Free Charcoal, J. Phys. Chem., 31: 8, 1197-1211, Aug., 1927.

Miller, E. J., and Bandemer, S. L. Adsorption from Solution by Ash-Free Adsorbent Charcoal. IV, J. Am. Chem. Soc., 49: 7, 1686-97, July, 1927. V, J. Phys. Chem., 32: 6, 829-42, June, 1928.

[15] Horton, Paul M. The Decolorizing Action of Bone Char. Ind. and Eng. Chem., 15: 5, 519-20, May, 1923.

McKee, R. H. and Horton, P. M. Adsorbent Carbons for Many Industries. Chem. and Met. Eng., 32: 13-16, January, 1925. Chem. and Met. Eng., 32: 164-7, February, 1925.

[16] Lamb, Wilson and Chaney. Ind. and Eng. Chem., 11: 420, 1919.

[17] Mantell, C. L. Industrial Carbon. D. Van Nostrand Co., 1928.

[18] Kolthoff, I. M., and Van Der Goot, Miss E. The Adsorption of Hydroxybenzenes and Other Aromatic Compounds and Their Replacing Action Upon Each Other at the Interface Water-Charcoal. Recueil Des Travaux Chimiques, 48: No. 3, March 15, 1929.

[19] Harold, C. H. H. The Role of Ammonia in the Purification of Water. J. Roy. Sanit. Inst., 48: 484, 1928.

[20] Houston, Sir Alexander. 19th and 20th Annual Reports, Metropolitan Water Board, London, 1925 and 1926.

[21] Adams, B. A. The Chloramine Treatment of Pure Water. The Medical Officer, Feb., 1926.

[22] McAmis, J. W. Prevention of Phenol Tastes with Ammonia. J. Am. Water Works Assoc., 17: 341, 1927.

[23] Harrison, Louis B. Chlorophenol Tastes in Waters of High Organic Content. J. Am. Water Works Assoc., 21: 542-49, April, 1927.

[24] Spaulding, Charles H. Preammoniation at Springfield, Ill. J. Am. Water Works Assoc., 21: 1085-96, Aug. 1929.

[25] Braidech, M. M. The Ammonia-Chlorine Process as a Means for Taste Prevention and Effective Sterilization. Ninth Annual Report Ohio Conference on Water Purification, pp 67-83.

[26] Cox, C. I. The Prevention of Chlorophenol Tastes in New York State. J. Am. Water Works Assoc., 21: 1693-1704, December, 1929.

[27] Klein, W. J., and Brown, C. Arthur. Removing Color, Tastes and Odors from a Widely Fluctuating Supply. Water Works Engineering, 83: 283, Feb., 26, 1930.

▼

Hackensack Water Co.'s New Collection Method a Success

The new collection procedure of the Hackensack Water Co. is developing successfully, according to a report by C. J. Alfke, comptroller of the company, to President Nicholas S. Hill, Jr. Statistics compiled by the comptroller's office from 51 cities and towns in Bergen and North Hudson Counties, N. J., indicate that the discontinuance of collectors is proving advantageous both to the public and to the company.

The company aimed to reduce to a minimum the practice of shutting off service, which, experience has shown, in many instances worked injustice to water users. Another aim was to eliminate the irritating relationships which frequently resulted from personal visitation, now regarded as obsolete.

Water bills are now paid either directly to the company or to banks. Delinquent accounts, after ample opportunity for payment has been afforded, are referred to attorneys. Water service is no longer cut off except in rare cases where every other method of inducing a customer to pay has failed.

Twenty-four banks throughout the territory served by the company now act as collection agencies. This method of payment is growing in favor with consumers. In some localities 25 to 50 per cent of the water bills are paid at banks. Illustrating the extent of the detail involved, Comptroller Alfke reported that the company has about 70,000 quarterly accounts which are read and billed daily except Saturdays throughout each quarter under a continuous billing system.

"Our accounts outstanding are no greater in number than they were under our old system, though economic conditions are not as favorable for collections," he said in summarizing results reached during the development period of the new system, which, it is expected, will ultimately both effect economies and establish higher standards of public relations.

▼

Unusual Design in Welded Pipe Line

An unusual design in welded pipe construction will be employed for a new line for the city of Detroit, Mich., contract for which was awarded recently. This latest contract, the third and largest that they have ever awarded for electric welded Armco ingot iron pipe calls for 2,100 tons or 7,100 ft. of 54 in. and 5,600 ft. of 56 in. pipe. The contract for furnishing and laying this pipe line was awarded to A. Phelps & Son, Detroit, Mich. The pipe will be fabricated by the United Welding Co., Middletown, O.

The pipe will be delivered in 40 ft. lengths for the 54 in., and 30 ft. lengths for the 66 in. The 40 ft. lengths, which are 33 1/3 per cent longer than the standard, will be made of four plates. In 7,000 ft. of 54 in. pipe, this increase of 10 ft. per section, will result in a large reduction of field joints with accompanying economy in field work.

Although welded construction, the pipe will be formed like the old-fashioned riveted page. Plates of pure iron, ½ in. thick and 122 in. wide, either 173¼ in. or 212 in. long, will be rolled so that one plate will go entirely round, forming a complete ring of pipe. Four of these rings (in the case of the 40 ft. section) will be lap-welded in the shop, making a 40 ft. section. This design was first used in the installation of 9,300 ft. of this pipe last May at Detroit and again in November when 9,000 ft. was laid. The circular seams lapped approximately 1½ in., will be welded inside and out, while the longitudinal seams will be butt-welded. In and out courses will be used throughout each section of the pipe. The section will be carefully tested for tightness and the surface thoroughly cleaned and dipped in protective coating before shipment. This combination of the old design and its new application gives a pipe that is unusually stiff, because of the lap-welded circular joints. This it is stated, makes it possible to place the pipe under deep fills without angle reinforcing rings.

Sewage Chlorination for the Protection of Masonry Sewers Against Disintegration

Role of Bacteria in Disintegration of Sewers—Intermittent Chlorination Will Suppress Biological Activity and Prevent Trouble—Experiences in Orange County, Calif., Show Effectiveness of Chlorine as Weapon

By LINN H. ENSLOW*
Associate Editor

NOTWITHSTANDING the generally satisfactory service secured from masonry sewers it is nevertheless true that occasionally such sewers are attacked and disintegrated because of septic sewage. Whenever sewage travels long distances or flows sluggishly through relatively short sewers, bacteria use up the free oxygen and thereafter break down the sulphates present to get the oxygen present in the sulphate radical. When the supply of oxygen is depleted the sewage is considered septic. Such sewage is dark brown, if not black, and hydrogen sulphide gas is frequently liberated when the sulphates are broken down. This gas produces odor nuisances and attacks the masonry and metallic parts of sewers. In normal sewage of domestic origin none of this destructive gas is liberated unless the sulphate content of the spent water supply (sewage) is relatively great. Frequently the high sulphate content can be traced to industrial wastes.

In case hydrogen sulphide should be produced, it is now no longer a problem of a serious nature because this trouble can be corrected by application of chlorine to the sewer. Since the development of this remedy, the selection of construction materials for sewers and manholes can be made without fear of consequences from septization of the sewage. In addition to sewer protection, chlorination of the sewage simultaneously prevents odor nuisance, renders the sewage less infectious and reduces its oxygen demand.

Disintegration of Sewers.—Disintegration of sewers and manholes above the flow line is caused indirectly by living organisms on the surface of the walls. As mentioned above, certain species of bacteria break down the sulphates and utilize the oxygen contained; the resulting hydrogen sulphide leaves the sewage to accumulate in the barrel of the sewer and is thereafter transformed, in part at least, into sulphuric acid. The next step is the attack of calcium and magnesium compounds in the concrete work, in the mortar joints between brick and vitrified materials and in the metal work. Starting with calcium sulphate in the sewage the cycle is completed when sulphates are again produced by the acid attack of the sewer walls and returned to the sewage through leaching action. Later another cycle may be begun further down the sewer and the same sulphur may thereby produce a repeated attack. If the attack progresses sufficiently, the walls or joints are penetrated to an extent which may cause failure of the structure. Such failures have been recorded in connection with brick and mortar construction, and occasionally concrete structures suffer.

To picture the sulphur cycle in sewage the reactions cited below are sufficient for illustration notwithstanding the evidence indicative of intermediate reactions which are not shown. Calcium sulphate is used for illustration, but other sulphates are brown down, also. In these reactions the presence of the essential biological forms, including bacteria, is indicated by the letter "B." The supply of oxygen is taken from the air entering the sewer. It is obvious that if there are no sulphates present in the sewage there will be no "gas attack." It is equally evident that sterile sewage will not cause any trouble.

$$CaSO_4+2H_2O+2CO_2+B=Ca(HCO_3)_2+H_2S \quad (1)$$
$$H_2S+2O_2+B=H_2SO_4 \quad (2)$$
$$H_2SO_4+CaCO_3=CaSO_4+H_2O+CO_2 \quad (3)$$
$$CaSO_4+2H_2O=(CaSO_4:2H_2O) \quad (4)$$

If the reactions stopped with (3) it would be serious enough, but in addition (4) occurs. The sulphate takes on water and crystallizes into gypsum. The phenomenon is in all essentials similar to freezing of water and the wedge effect and swelling produced cause rupture of the structure, spalling of brick, loosening of liner plates or cracking of concrete pipe and segment block. It has been observed that the "putty" produced by the gas attack has a volume two or three times that of the original mortar or concrete. Reactions (1) and (2)

* Research Engineer, The Chlorine Institute, Inc.

Chlorinator House, Santa Ana, Calif.

Chlorinator House, Fullerton, Calif.

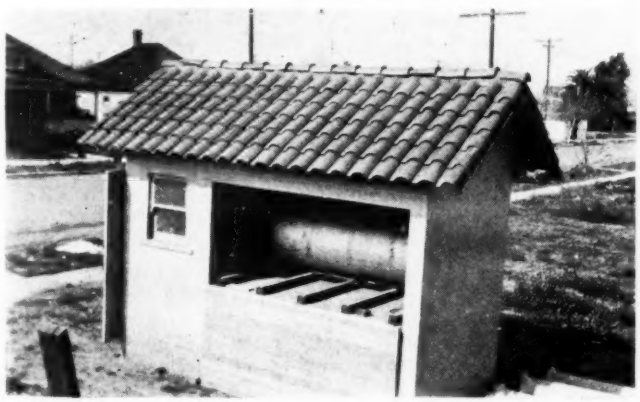
are the most important and are those caused by bacteria. Without the first there would be no odor nuisance, and without the second there would be no sewer destruction. Since without (1) there would be none of those following, the entire trouble can be stopped by suppressing biological action in the sewage. In cold weather, sewer attack and odor nuisances are not in evidence solely due to subdued biological activity.

It is obvious that chlorination is required during the hottest periods of the year and can be dispensed with during other periods. For other reasons it is feasible to discontinue the chlorination process during the night when the sewage consists very largely of water and, having smaller volume, does not flow in contact with slime deposits thriving on the side areas of the sewer between the maximum and minimum flow lines. Because of this modified treatment the chlorine required is not sufficient to render the process unduly expensive. The use of the 1-ton chlorine container, as pictured here, has greatly decreased the cost of chlorination of the Orange County sewer in California.

Experiences in Orange County.—Largely because of successful control of odor nuisance by chlorination at the Schenectady, N. Y.; Independence, Kan., and Plainfield, N. J., sewage plants, the California State Department of Health and the Chlorine Institute, carried out some studies on the Orange County sewer in 1928. The results were gratifying and R. F. Goudey in his paper (1) says that chlorine applied in moderation at one or more points along the Orange County sewer "practically stops the sulphate splitting action and in addition to controlling odors, prevents formation of sulphuric acid with its consequent destructive action. By chlorinating at an estimated cost of $3,000 per year, the outfall sewer investment of nearly $1,000,000 can be saved."

Since the completion of these studies, five of the cities contributing sewage to the Orange County outfall sewer have completed permanent chlorinator installations such as are shown here. Inspections at frequent intervals have since shown that the attack on the sewer has practically ceased. Odor nuisance from manholes has been eliminated and beach protection is afforded at the same time.

The practice is to apply chlorine during the hours of maximum sewage flow only; i. e., 9 to 12 hours daily. The quantity of chlorine used is roughly 5 p.p.m. when calculated from the daily flow covering the entire 24 hours; i.e., for each million gallons of sewage delivered to the sewer the contributing town applies 40 to 45 lb. of chlorine. With a chlorine price of 5 ct. per lb. in ton containers delivered by truck this amounts to $2.00 to $2.25 per m. g. of sewage. For large sewers chlorine is available at lower prices in car lots of ton containers; Baltimore, Md., for example, secures chlorine at 2.75 ct. per lb.



Chlorinator House, Orange, Calif.

The Orange County sewer is an extreme case. The trunk outfall is 26 miles long with branches entering along its course. Many of the branch lines are 5 miles or so in length.

Front View, Fullerton, Calif., Installation, Showing Chlorinator and End of 1-Ton Chlorine Container through Wall Opening

General.—For the reader desiring more complete information a selected list of references is given. The following brief statements may be of interest. The Spirillum desulfuricans is probably the most common organism causing the break-down of sulphates to sulphides. The sulphur-loving bacteria of the Beggiatoa group are largely responsible for the acid production from the sulphides (2). Temperature plays a most important role in hydrogen sulphide production—the range between 77 and 86 deg. F. being optimum for some species of sulphate-splitting bacteria (3, 4, 5, 6). Others function best at temperatures up to 131 deg. F. (7, 8). Certain studies have led to the conclusion that intestinal organisms (B. coli communis) in themselves are responsible for hydrogen sulphide production in sewage and packing plant wastes (6).

Certainly as early as 1897, and probably before this, it was believed that the sulphide gas in sewers was the agent responsible for sewer destruction. This was discussed by the late Rudolf Hering (12) in 1910, and was also carefully noted by Barr and Buchanan (2) in 1912.

Means of lining sewers with acid-resistant materials in the use of protective coatings have been resorted to. As recently as Sept. 1, 1927, *Engineering News-Record* in its editorial columns remarked, "Despite the years of use of concrete in sewers the whole subject of sewer attack is still in so nebulous a stage that all experimentation thereon is well worth while" and further on, "For some years Los Angeles (city) has been lining its sewers with clay tiles and this practice has been

followed more recently at other places. . . . Now at Los Angeles it is found that these liners are none too secure when placed with mortar joints. . . ."

It seems strange that, during the many years intervening between the recognition of the cause of sewer disintegration and the present, the chief weapons used against it were those for combating *effect* alone and that not until 1928 in California was there developed a practicable means of eliminating the *cause*. To this end any means of depressing bacterial activity may be applied; chlorination is merely one means which has proved simple, practical and economical without burdensome initial investment and labor cost.

REFERENCES

1. R. F. Goudey. Sewage Works Jour., vol. 1, No. 2, p. 196, Jan., 1929. Calif. Sewage Wks. Jour., vol. 1, No. 1, Dec., 1928. Western Construction News, Jan. 10, 1929.
2. W. M. Barr, R. E. Buchanan. Jour. Ind. Eng. Chem., vol. 4, p. 564, Aug., 1912. Bull. No. 26, Eng. Expt. Sta., Ia. State Col., 1912.
3. F. H. Olmstead, Homer Hamlin. Engineering News, vol. 44, p. 317, Nov., 1900.
4. M. Beijerinck. Centr. Bakt. Parasitenk II, Abt. vol. 1, p. 104, 1895.
5. Bastin. Bull. Am. Assoc. Petro. Geol., vol. 10, p. 1270, 1926.
6. L. Elion. Jour. Ind. Eng. Chem., vol. 19, p. 1368, Dec., 1927.
7. W. D Hatfield Pub. Works, vol. 58, p. 504, June, 1927.
8. Heilmann. Chem.-Zeitung, vol. 52, p. 482, 1928.
9. A. B. Porter, A. J. Cresswick. Jour. Soc. Chem. Ind., p. 380T, Dec. 28, 1928.
10. L. H. Enslow. Water Works, Dec., 1927. The American City, May, 1928.
11. J. L. Barron, R. E. Lawrence. Eng. Bull. No. 16, Univ. Kans., Feb., 1928.
12. Rudolf Hering. Trans. Am. Soc. C. E., vol. 67, p. 592, 1910.

▼

Lagooning Sludge

Experience with Sludge Drawn from Digestion Chambers of Imhoff Tanks at Dallas, Tex., Sewage Disposal Plant

By EDGAR WHEDBEE

City Water Department, Dallas, Tex.

THE city of Dallas, with its environs, has a population of approximately 300,000 persons. There are quite a number of industries which produce considerable trade waste, the ones contributing most being a paper mill, two meat-packing concerns and one or two soap factories. While the packing plants are not very large, one, during 1924, killed 107,121 hogs, 5,653 head of cattle, 1,653 calves and 227 sheep; the waste discharged amounted to 200,000 g. p. d., which in strength is equal to approximately 2 m. g. of domestic sewage.

The plant at Dallas consists of 24 Imhoff tanks, designed by James H. Fuertes. Twelve were placed in operation in 1917. Of an additional twelve, six were put in operation in April, 1925, and the other six a little later in the same year. The tanks are about 33 ft. deep, 43 ft. long and 30 ft. wide, with two flow-through compartments and a single gas vent in the center. The sludge beds are about 300x145 ft. in area. During extended rainy spells these beds were filled and the digestion compartments became overloaded; when accompanied by foaming, the tank became a large septic tank.

Slough Utilized as Lagoon.—In the early part of 1926 some experiments were started on the feasibility of chlorinating the effluent in lieu of secondary treatment. At the same time the sludge line to the dry beds was extended down to an old slough, so that excess sludge over the dry-bed capacity could be placed in the slough. Cleaning of flow chambers and gas vents with men and wheelbarrows was started, but this was too slow, so the vertical pipes of the sludge lines were cut off about 3 in. below the ordinary flow line, a removable plunger was placed below the tee in the sludge and the scum was run into the lagoon with very slight trouble. The scheme worked so well that skimming troughs were installed at one end of the flow chamber. At times before any skimming devices were added, the flow chamber would have scum upon it that would analyze as much as 53 per cent of ether-soluble fats and, when dried upon beds, would burn like oil.

Saving Through Lagooning.—The lagoon took care of the skimming and excess sludge, so it looked as though the dry beds could be cut out. Four men composed the dry-bed gang. Labor ran from $12.80 to $16.00 a day—or say an average of $14.00; for 313 days this amounts to $4,382. Pea gravel for the beds required 150 cu. yd. at $2.50 a yd.—a total of $300. Repairs to cars, cost of building track, etc., added another $318, bringing the total saving brought by the lagoon to 5,000. The lagoon was started in 1926, when scum and excess sludge were run into it. Beginning in September, 1927, all sludge and skimmings were run into it. The lagoon is about 5 or 6 acres in extent, and some levee work has been done on the north, east and west sides. No odors have been experienced from the lagoon.

There are two outlets—one at each end. The upper one is an open ditch which follows the contours of the old slough, and from which the clear liquid evaporates during the warm season. On the other end a 3-in. pipe has been placed through the levee. The clear liquid is decanted through a gate valve. During high water in May, 1929, nearly all of the floating scum was washed over the levee. Having dried out by August, it was set on fire, and it burned for several months.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 12th Texas Water Works Short School at Abilene.

▼

New York Sewage Works Association to Meet at Syracuse

The New York Sewage Works Association will hold a meeting Sept. 13 at the Onondaga Hotel, Syracuse, N. Y. The program includes the following:

9:00 A. M.—Registration
10:00 A. M.—Business Meeting.
10:45 A. M.—Technical Session—Papers and Discussions.
"Use of Chlorine in Connection with Plant Operation"—L. H. Enslow.
"Stream Pollution from the Operator's Standpoint"—Prof. E. B. Phelps.
12:30 P. M.—Recess.
12:45 P. M.—Luncheon, Onondaga Hotel.
Brief Description of Works to be visited.
2:00 P. M.—Inspection Trip to include—
Syracuse Main Sewage Treatment Works.
Sludge Disposal at Lime Waste Beds.
Sludge Digestion and Control at Small Plant, Eastwood.
6:00 P. M.—Return to Hotel.
6:30 P. M.—Dinner at Hotel Onondaga.
7:45 P. M.—Round Table Discussion.
1. "Metal Preservation above and below Sewage Surface"—R. S. Rankin.
2. "Garage Wastes"—John F. Skinner.
3. "Experience with Small Pumping Stations"—Harry W. Eustance.
4. "Pumping of Sewage Sludge"—Irving Nevitt.
10:00 P. M.—Adjournment.

Private Cross-Connections and Similar Menaces to the Quality of Water

Possibilities of Pollution Through Fixtures—Submerged Inlets Classified—Direct Connections to Waste Pipes—Examples of Pollution—Proposed Remedies

By JOEL I. CONNOLLY

Chief, Bureau of Sanitary Engineering, Department of Health, Chicago, Ill.

THE dangers of cross-connections between a drinking-water supply and an impure supply have been recognized for years, and measures have been taken by water-works and public health authorities to guard against them.

The pollution of water by drainage or siphonage from fixtures having submerged inlets and by siphonage from waste pipes is a similar menace to health. The presence of this danger is easily demonstrated in almost all buildings of large size and frequently in smaller ones. The increasing use of fixtures where such pollution is possible has made the correction of the existing conditions necessary, and the longer the matter is put off the more difficult will the task become.

In order to simplify the question before us, let us consider the following items:

1. Every plumbing fixture directly connected to a waste pipe or stack in the plumbing system is a part of that system, and the sewage may back up into the fixture in case a stoppage occurs.

2. Water held in fixtures and traps may be contaminated in the course of their customary use, as well as by backing up of the sewage.

3. If the water inlet to the fixture be submerged in such contaminated water or sewage, the reduction of the water pressure in the inlet pipe to a value lower than the static head will cause, upon opening the inlet valve, a return flow of the fixture contents into the drinking-water supply pipe.

4. Self-closing valves actuated by the water pressure in the supply pipe, such as the common types of flush valves for toilets, become self-opening valves when the positive water pressure becomes changed to a negative pressure or partial vacuum.

5. The partial vacuum in a supply pipe is a common occurrence in many localities, due to (a) excessive use of water at lower elevations, (b) insufficient pumping capacity, (c) heavy draught upon fire hydrants in the vicinity of fire engines, (d) shutting off the supply while making repairs, and to other common occurrences.

6. In large buildings, especially, there is no ready means for the user of a fixture to determine definitely in advance whether a positive pressure or a partial vacuum exists in the supply pipe. The valve is opened and if there is no pressure, one simply waits for water.

Submerged Inlets Classified. — Submerged inlets to fixtures may be classified into two major groups, as follows:

Class 1. Inlets constantly submerged beneath the surface of the fixture contents when the fixture is in normally good operating condition.

Examples of Class 1: Siphon jets in water-closet and urinal traps, steam tables, laundry washing machines, swimming pools, instrument sterilizers, jets in bottom of water-closet bowls used for washing bedpans, bell-supply bath tubs including therapeutic tubs, water baths for many purposes, hydraulic lifts, processing tanks, heating boilers, Bidet fixtures, filters, softeners, stock-watering basis.

Class 2. Inlets not ordinarily submerged beneath the surface of the fixture contents, but which at times become submerged due to carelessness in filling or to stoppage of outlets.

Examples of Class 2: Flushing rim openings in water-closets, urinals and slop sinks; lavatories, bath tubs, utility-room sinks, dishwashing machines, spray heads in air washers, drinking fountains, bed-pan sterilizers.

These examples do not comprise all submerged inlet fixtures but serve to illustrate the differences between the groups.

When fixtures in Class 1 receive human excretions, the greatest precautions should be taken to prevent the entry of the fixture contents into the drinking water.

A flush valve not equipped with a vacuum-breaker device is useless for the purpose of preventing siphonage, because the creation of a partial vacuum in the supply pipe immediately opens the valve. The usefulness of any vacuum breaker upon a flush valve depends, first, upon the valley being closed when the partial vacuum is produced, and, secondly, upon the ability of the device to pass enough air to prevent the formation of a vacuum in the compression chamber of the valve, which, if formed, would open the valve and permit siphonage.

The Menace to Sterile Water Supplies.—For many years surgeons have sought for the cause of post-operative infections. Some factors were discovered and eliminated but still infections continued, sometimes in explosive outbreaks strongly suggesting an undetermined common means of infection. Two years ago Dr. Arnold Kegel, commissioner of health in Chicago, pointed out in an unpublished paper before the Illinois Medical Society that the infection of the water supply by siphonage from a bottom-supply instrument sterilizer, followed by leakage of the germ-laden water into the sterile water tanks through a defective valve, would account for these outbreaks. This was an observation of great importance because wound infections by hemolytic streptococci usually result in the death of the patient.

Direct Connections to Waste Pipes.—An unbroken, or direct, connection from a water-supply pipe to a waste or sewer pipe is not uncommonly found. Very frequently filter or softener drains and wash-water wastes are directly connected to the house drain, in such a position that sewage may back up into the filter or softener during times of storm. Frost-proof closets and cooling coils in ice machines, water stills and water sterilizers are often found to have unbroken connections to waste pipes through which sewage could be siphoned into the water supply. In one instance, ammonia escaping into the cooling coil blew the water back into the street mains, and acting upon the bronze valves, colored

the water blue with copper compounds throughout the neighborhood.

Drains to water stills and water sterilizers also are directly connected to waste pipes, in many instances. This is a pernicious practice, since the condensation of the steam to produce the distilled water, or after sterilizing the water, respectively, produces a partial vacuum which may easily suck sewage into the distilled or sterile water. Such a case has been observed where the attendant thought she was distilling water at an unprecedented rate, but was actually siphoning sewage into the distilled water tank.

Priming connections to sewage pumps are occasionally found. In November, 1927, an epidemic of gastro-intestinal disease among one hundred employees of a large power house in Chicago was traced to a 1-in. connection for priming a pump handling polluted water.

The Remedy.—It is much easier to find improper and dangerous connections in the water-supply pipes than it is to tell just how to remove the danger. Numerous vacuum breakers and check valves have been designed and used. The best way, from the standpoint of entire safety, is to remove all submerged inlets to fixtures and all direct water connections to waste pipes.

If this cannot be done, it may be possible to have every riser open at the top to the air, so that no vacuum could ordinarily be formed in the riser. Where there is a house tank, this can be done by having each riser (except the one supplying water to the house tank, of course) continue full size, uninterruptedly from a point below the shut-off valve, to an elevation above that of the water surface in the house tank, and end in an open return bend to prevent things from dropping into it. As the riser is drained, air will enter the open end and prevent the formation of a vacuum.

Where there is no house tank, the formation of a vacuum in risers may be prevented by proper use of vacuum breakers. In either case the branch leading from the riser to the submerged inlet should be carried up at some point between them to an elevation at least several inches above the rim of the fixture, so that the water will not drain back into the riser because of its own weight.

To eliminate all submerged inlets would mean to rule out flush valves and go back to the use of flush tanks for toilets. There are sound advantages in the use of flush valves, such as economy of space, and not having to wait between flushes, which make one hesitate to adopt so drastic a step. On the other hand, unless precautions are taken in the riser, as mentioned above, some protection at the fixture is essential, as it has been found that with certain types of siphon-jet bowls, it is possible to siphon from the trap of the closet through the jet opening, even while the rim openings are drawing in air.

A good vacuum breaker in the flush valve is of great value, but most, if not all, of those now commercially available leave very little factor of safety for possible leakages past the cup leathers on the plunger, or for failure of the main valve to seat tightly. It is my tentative opinion, based upon unfinished studies, that with fixtures having inlets occasionally submerged (Class 2, as described above) and for use with filtered water, or in places where the creation of a partial vacuum is very improbable, the best of such built-in vacuum breakers in flush valves may prove to be a practicable remedy, provided the valves are properly serviced and kept in condition. For Class 1 inlets, that is, those constantly submerged, and in places where siphonage occurs frequently, some additional protecting device, or a larger air capacity than that of the built-in vacuum breaker in flush valves now on the market, will probably be required for adequate protection.

Certain special types of rubber-faced check valves also may prove, upon further investigation, to give adequate protection to flush-valve connections for occasionally submerged (Class 2) inlets when used with a filtered water supply, or when used in places where the creation of a partial vacuum is very improbable. A combination of check valve and a vacuum breaker of adequate size to prevent a vacuum in case the check valve is held open by débris lodged in it, appears to be the safest available solution of the flush-valve difficulty when such valves are used with constantly submerged (Class 1) inlets and with an unfiltered water supply or in a location where siphoning is frequent. Preliminary tests by the writer indicate that it is possible to have large obstructions in the checkvalve and flush valve, holding them both open simultaneously, and still prevent contamination, by the use of a properly designed and adequately sized vacuum breaker in the water-supply pipe on the fixture side of the check valve. Further tests are now being made to determine the effect of the passage of time upon these devices.

On lavatories and bath tubs the inlets should be placed above the rim of the fixture. Seldom will the overflow openings in such fixtures be found to be large enough to carry off the water as fast as it enters. Where it may be necessary for any reason to have a bell supply, as in a therapeutic tub, special attention should be given to the provision of some adequate device to prevent the formation of a vacuum in the supply pipe, such, for instance, as a combination of check valve and vacuum breaker mentioned above.

Direct water connections to waste pipes should be cut off and the water discharged into a funnel or pipe of larger size, properly trapped. The end of the water pipe should be above the funnel rim.

Conclusions.—To prevent water pollution through submerged inlets to fixtures and direct waste connections, all water-pipe and waste-pipe installations must be more carefully supervised. Manufacturers must join forces with water-works and health authorities to develop safer fixtures or provide protective devices to prevent back pressure and siphonage. All direct water connections to waste pipes should be severed. Whenever possible, submerged inlets should be removed and the water should enter over the rim of the fixture. Where that is not possible the purity of the water supply should be protected by an adequate non-siphoning device.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 50th annual convention of the American Water Works Association.

▼

Central States Section A. W. W. A. to Meet at Youngstown

The annual convention of the Central States section of the American Water Works Association will be held at the Hotel Ohio, Youngstown, Ohio, Sept. 25 and 26, 1930. The program, which is now being arranged, will include papers on water-works accounting, financing of extensions and improvements, water purification and other subjects of interest. A special feature will be an open discussion of practical questions of operation and maintenance of water works and water purification plants. A half-day will be devoted to an inspection of near-by water-works developments.

The Determination of Total Alumina in Filtered Water

Significance in Plant Operation—Necessity for Accurate Control—A New Method for the Determination of Unprecipitated Alum

By F. O. BALDWIN
Superintendent of Filtration, Richmond, Va.

AMONG the many essentials for satisfactory and efficient filter plant operation we have the very important step in water purification of coagulation. This phase continues to command the attention of those in charge and at times baffles even the most experienced. Often the results from coagulation are very poor and adequate explanation of why this is so is difficult—especially if this explanation is to be made to one other than a chemist in the water purification field. Sometimes an imposing array of analytical data accumulated in the laboratory at great labor and expense apparently fails to disclose the secret of poor coagulation. In many cases failure is due to lack of knowledge and to much guessing. This includes the apparent mysteries attached to a rapid change in character of the raw water or else to some subtle influence in plant operation which has been overlooked. There is also such a thing as poor coagulation from lack of proper facilities and due to fundamental errors in plant design.

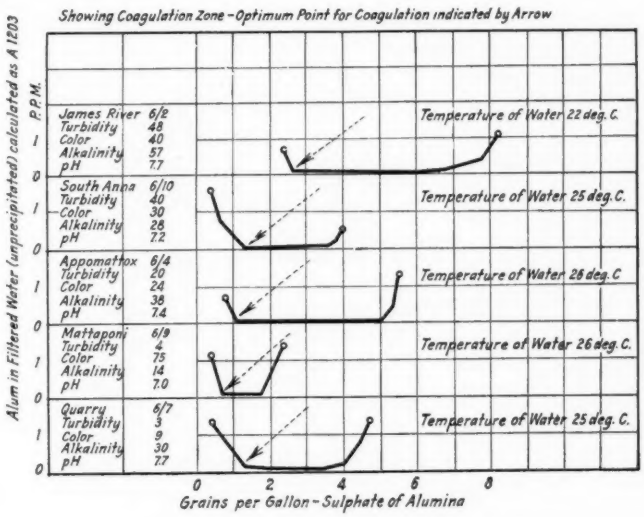
Accurate Control.—Aside from these many reasons for poor results the fact remains that in a considerable percentage of cases there is inaccuracy in dose control methods for alum or other coagulant. This condition of couse usually means surplus expense and a poor quality of filtered water. Too often the dose of alum is the outcome of "rule of thumb" or perhaps is based solely upon "the appearance of the floc."

In an effort to eliminate a very large amount of uncertainty attached to determining the proper dose of alum the enclosed chart has been prepared by means of actual coagulation experiments. This chart represents coagplation results from five sources of raw water as different in character as was possible to obtain within a radius of 40 miles of Richmond. A rapid and accurate means of determining unprecipitated alum made it possible to prepare this chart.

The first thing which we note from the chart is that when the dose of alum is too small, a very large part of the alum fails to precipitate. As we approach the correct or optimum dose, the residual alumina (as the unprecipitated alum will hereafter be designated) becomes less. Finally, when the optimum dose is *struck*, practically no residual alumina is found in the filtrate—usually less than 0.08 p.p.m. At this point analysis shows a very high quality of water, the turbidity having dropped to zero and the color below 2 p.p.m.

Suppose, however, we are dealing with a water which has considerable alkalinity, as the James River shows, for instance, on the chart. Once we *hit on* the optimum dose, it is easy to move along the *nearly horizontal line*, and the degree of surplus alum and therefore *unnecessary* expense can be measured very accurately by the distance back to the optimum dose as indicated by the arrow. Once the optimum dose is reached, any increase in the dose, well within the alkalinity range, does not furnish any improvement in the quality of the water, and the added cost for alum is entirely unnecessary.

Of course there are unusual cases where lack of facilities would make it advisable to add a larger dose of alum than the optimum in order to accelerate floc formation. This would be a case of extra cost for coagulant to compensate for lack of capacity or probably error in plant design. In many filtration plants it is the practice to regulate the dose by such factors as appearance of the floc, the rate



Diagrams Showing Coagulation Zone; Optimum Point for Coagulation Indicated by Arrow

of settling and the appearance of the areas of clear water between the particles of coagulated material, supplemented by filtering through cotton or filter paper and noting the turbidity and color reduction in the filtrate. These observations and tests are excellent, but they fail to show the unprecipitated alum and the degree of surplus dose of alum beyond the optimum point.

Determination of Unprecipitated Alum.—From 1921 to 1924 a method for determining unprecipitated alum in water was developed in the laboratory of the Richmond plant by the writer. This method has been used as a routine determination in both the old and the new Richmond water purification plants for more than seven years and has been a decided asset towards efficiency and economy during this period. The method was published in the December, 1924, issue of the *Journal* of the American Water Works Association under the title, "Total Alumina in Water (Modified Atack's Method) Colorimetric Determination."

The method as originally published was somewhat difficult, but recently it has been rendered very simple (an enormous amount of work was involved). The determination requires less than ten minutes, and its

Alumina Test Apparatus

accuracy has been increased rather than diminished. The number of reagents used is three and a person unskilled in manipulating any sort of apparatus could learn to use the set in a few minutes.

The accompanying cut shows the complete apparatus including reagents, color standards and neat, hardwood mahogany portable carrying case. This case is very important as it protects all apparatus from possible contamination with alum dust.

The principle that alumina possesses an unusual property or faculty of combining with certain dyes is used. F. W. Atack was probably the first to apply this lake formation property to determining minute quantities of alumina in various substances.

The method is sensitive to one part in ten million as Al_2O_3. It furnishes a sort of hairline control of the dose of alum and in our particular case, but for the fact that the James River as a raw water supply is at times extremely difficult to treat, it would probably be possible to hold the dose of alum well within one-tenth of a grain per gallon of the optimum dose. The method in its simplified form is as follows:

Reagents

1. Three-tenths per cent aqueous solution of alizarin red S (alizarin sodium monosulphonate) in 2N sulfuric acid.

2. Saturated solution of sodium bicarbonate. Filter through alumina-free filter paper and add 2 cc. of distilled water per 100 cc. of filtrate. The strength of this soda solution should be held close to a normal solution—that is, 8.4 per cent $NaHCO_3$. Use Arm & Hammer brand of soda—this grade is usually pure enough for most purposes.

3. Fifty per cent acetic acid. This should be made from the highest grade reagent acid and boiled distilled water.

Procedure

To 50 cc. of the freshly collected and well shaken filtered water add 1 cc. No. 1 (0.3 per cent $ARS2NH_2SO_4$). Use phosphoric acid flasks, size 200 cc. Boil 2 minutes on hot plate, neutralize with No. 2 (8.4 per cent $NaHCO_3$) to just barely purple by adding the soda solution very carefully drop by drop and then add exactly 0.5 cc. excess and boil 2 minutes and cool in *cold water*. When cold add 1 cc. of No. 3 (50 per cent acetic acid), let stand 1 minute and compare with color standards sealed in Pyrex 200-cc. flasks similar to the above flask. These color standards are sealed in a partial vacuum, and have to be standardized very accurately.

Acknowledgment.—The foregoing paper was presented at the second annual conference of the Virginia Water and Sewage Works Association at Norfolk, Va.

Sanitation of Roadside Supplies Brings Results

Results of the campaign started in 1923 by the State Health Department of Ohio on that phase of roadside sanitation involving the safety of water supplies used by the traveling public are set forth in the Sept. 1 Ohio Health News.

For purposes of the study, the tier of county general health districts along the Old National Road—U. S. Highway 40—were selected, because the National Road has the largest number of certified water supplies to be found along any Ohio highway, both in actual number and in proportion to its mileage.

Typhoid fever is the chief water-borne disease, and since the general utilization of methods of water purification by municipalities, the larger proportion of typhoid develops in rural districts. With the more general utilization of the automobile for travel, the incidence of rural typhoid was intensified along the main arteries of traffic. For purposes of comparison, the following tables show the typhoid incidence in the selected health districts for the six-year period preceding inauguration of the Seal of Safety campaign and the six-year period immediately following. The tables follow:

Preceding Seal of Safety Work

Gen. Health Dist.	1918	1919	1920	1921	1922	1923	6-yr. Totals
Belmont	39	27	28	51	27	20	192
Guernsey	10	40	12	51	28	15	156
Muskingum	14	7	5	29	19	17	91
Licking	22	19	16	29	14	8	108
Franklin	19	10	23	35	18	11	116
Madison	16	6	8	27	19	14	90
Clark	11	10	12	19	5	6	63
Montgomery	27	21	15	31	17	14	125
Preble	15	12	17	29	4	5	82
Totals	173	152	136	301	151	110	1,023

After Inauguration of Seal of Safety Work

Gen. Health Dist.	1924	1925	1926	1927	1928	1929	6-yr. Totals
Belmont	11	37	40	23	13	11	135
Guernsey	14	22	11	8	3	5	63
Muskingum	6	9	5	7	3	2	32
Licking	5	7	4	6	5	4	31
Franklin	12	11	27	1	12	5	68
Madison	6	3	8	4	0	0	21
Clark	5	5	4	3	10	2	29
Montgomery	13	15	7	4	5	4	48
Preble	3	5	3	5	2	5	23
Totals	75	114	109	61	53	38	450

By comparison with the first six-year period, the second, following the beginning of Seal of Safety work and coincident with its development, shows a reduction of more than 56 per cent in number of typhoid fever cases. It is not to be supposed that all of it is due to improved water supplies along the National Road, because there has been a very general improvement in both municipal and individual farm and homestead sanitation, not only along the highway but also throughout the entire territory. But the benefits of improved roadside sanitation have been so marked that they have resulted in a demand for improved private water supplies and for better sanitation generally, so that the influence of the Seal of Safety has been both specific and general, and a considerable percentage of the decline in typhoid incidence may be fairly credited to it.

SEWAGE DISPOSAL WORKS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. DOWNES, Associate Editor
Supervising Engineer, the Plainfield and Dunellen, N. J., Sewage Disposal Works

Trickling Filters

WHILE the idea of the sprinkling or trickling filter was conceived some 40 years ago and while this idea has been developed into one of the most satisfactory and effective oxidation devices known to the art of sewage disposal, there is still very little definite information available on the subject; and there is apparent a wide diversity of opinion on several phases of the subject among workers who have been very intimately connected with the operation of such filters. Aside from the variety of theories expounded to account for the really remarkable results obtained by this device, there is still after 40 years no unanimity of opinion on the matters of ventilation, useful depth, effect of putting temporarily out of operation, etc.

Difference of Opinion.—Noel Chamberlain and I. O. Lacy, of the New Jersey Sewage Experiment Station, have recently made an exhaustive search of the literature on sprinkling filters and have listed some 360 references covering articles from the inception of the idea in 1891 to date, but the sum total of actual information shown to be available is disappointing. The present writer has read and reread the material offered in these references with the idea of presenting somewhat of a digest from which standards could be established, but he finds that apparently equally qualified authorities are at complete variance in such matters as the optimum relation between depth of filter and area, the desirability of rough or smooth filtering material, the depth within the filter at which the maximum oxidation takes place, etc.

The conclusions offered by each investigator seem to be well established by the data afforded in each experiment so far as those data go, and it would seem that the different results secured are due to differences in the influent used on the filters, particularly as regards the condition, or state of disintegration, of the applied influent. In the case of experiments of short duration, the season at which the experiment was made would have a marked effect on what conclusions would be drawn from an attempt to determine either the optimum depth of a filter or the point at which maximum oxidation would take place.

Effect of Preparatory Treatment.—During the years 1913 to 1916 the writer, working with septic tanks and double contact beds, was much impressed with the idea that each of these three steps of the process was merely a preparation for the next step, and that the measure of the success of operation of each step was to be found, not so much in the analysis of its effluent as in the results obtained in the next succeeding step.

There was an intangible something that prepared the onflowing sewage for further treatment, something not to be determined by the routine analysis and which we could not give a name with the facilities then at hand. It is probable that with our advanced technic and advanced knowledge of fundamentals we could now tie this indefinite condition up to pH, nitrogen-carbon ratio and predominating flora, as representing the exact point reached in the progressive disintegration process. If one investigator finds the point of maximum oxidation at the surface of a filter and another finds it near the bottom, it seems logical, from my conception of the progressive nature of the purification process, to assume that the conditions found in each case could be reversed by adding to or taking from the preparatory treatment.

To illustrate this idea crudely, consider an express traveling from New York to Chicago in 20 hours. If a man boards the train at any stopping point he may ride approximately 180 miles in 4 hours but the place he arrives at, at the end of that period of time, will depend on the point at which he boarded the train.

Now the *operator* will normally not be worried about whether a 10-ft. filter is more efficient than a 6-ft. filter. His worry is to make the best of the filter that someone else has provided him with, and this in connection with such other preparatory equipment as may have been provided.

Local Conditions.—If the sewage arrives at the plant in a fresh condition and there is an abundance of settling capacity, the operator could duplicate either the findings of Clarke, who found the greatest oxidation in the upper layers of the trickling filters, or of Rudolfs, who found that the oxidation (nitrification) was greatest in the 2 ft. nearest to the bottom of the bed. The different results would be obtained by using his settling tanks to capacity in one case, feeding to the beds a very thoroughly clarified but somewhat septic sewage, and in the other case by limiting sedimentation so that the sewage would still be fresh and might still contain some of the finer suspended solids.

The factors mentioned above would also affect the findings with regard to the optimum depth of sprinkling filters. In other words, it comes back to the same old question of local conditions. In applying the same influent to beds of various depths the results would depend largely on what stage of disintegration had been reached in the applied sewage at the moment of application.

Local conditions, also, would, of course, determine the desirable stage of disintegration at which the influent might be sent to the filters. My personal inclination is to get the sewage to the filters as fresh as possible and with the least possible sedimentation which will provide against filter clogging. This practice not only assists in keeping down odors at the sprays but passes on to the sprinklers, for aerobic treatment, the finer particles, which can in some instances, at least, be much more easily handled aerobically in the filters than

anaerobically with the sludge. The latter practice results, naturally, in a heavier unloading of the trickling filters and a larger bulk of humus to be disposed of. The "humus," however, is much more amenable to anaerobic digestion than was the material from which it results before treatment of the latter in the filter.

Not only can the operator get the best out of his sprinkling filters by using judgment in the amount of preliminary treatment given, but operators in general can add much to the total of information on the subject by recording and reporting the results of any investigations made to determine the proper degree of preliminary treatment.

Clogging.—Clogging of trickling filters, except in abnormal cases, is more likely to be due to growths on the bed than to the sewage solids themselves. Surface clogging and resultant pooling when caused by such growths is no longer a terror to the operator since chlorine treatment has been shown to be very simple and effective in eliminating these undesirable conditions without in any way interfering with the proper action of the filters. Where means for applying chlorine gas are not available, bleaching powder is found to be equally effective if somewhat more troublesome to handle.

The two objectionable features of trickling filter operation are odors disseminated at the sprays and the sewage sprinkling filter flies which breed in countless millions in the filter film.

Odors.—The former difficulty, odor, can now be effectively controlled by the use of chlorine in quantities just sufficient to oxidize the hydrogen sulphide. Any dosage which gives a slight residual of chlorine will assure the elimination of hydrogen sulphide. With the present low price of chlorine the cost of this treatment to insure against odors is very reasonable. This is particularly true since a study of local conditions will generally reveal that the application of chlorine is necessary only during certain very limited periods of the day. The quantity of chlorine required will vary from 10 to 20 parts per million parts of sewage actually treated. Since such treatment will seldom be required for more than 8 hours daily, the total quantity of chlorine used would be from 28 to 56 lb. for each m. g. of sewage flow. The cost of chlorine varies from 2.6 ct. per lb. for large quantities to 9 ct. for very small quantities.

Freshness of the applied sewage is, of course, an important factor in the amount of chlorine required. For really fresh sewage the requirement approximates zero while for very stale sewage it would run beyond the 20 p.p.m. mentioned above.

Filter Flies.—The other objectionable feature of trickling filters, the filter fly, is extremely difficult to contend with. The only known method of control at present is that of submerging the filter media at regular intervals, usually one week apart. By this means the eggs, larvae and pupae, the three preliminary stages of existence of the fly, are washed out of the filter bed and many of the larvae and pupae are killed by drowning. The full-fledged fly escapes by flying off the bed during submergence and is therefore not disposed of by this treatment.

The adult fly is noticed to be very active at certain early hours of the morning, flying in clouds within a foot or so of the bed surface and collecting on adjacent walls, walks, etc. A great many of these adults can be killed off by spraying such walls and walks with an insecticide, perhaps the cheapest and best of which is plain kerosene. These flies pay not the slightest attention to the ordinary toxic insecticides of either the eating or contact types. We feel that the killing off of such adults as we can reach with the kerosene spray is a valuable adjunct to control of the larvae and pupae by filter submergence, but we know that it is not by any means a substitute for the latter.

We have seriously considered mounting a giant vacuum cleaner on a light truck for the purpose of gathering up the adults during their morning flights, but the fact that only those which are flying free or crawling on dry surfaces could be swept up makes the possibility of actual control rather remote. A far greater number are crawling about in slight cavities on the underside of the surface stones and could not be reached. This latter habit also makes control by treatment of the beds with insecticides out of the question even if we could find an agent which would have any effect on these flies.

Getting the Best Possible Results from the Trickling Filters.—To get the best possible results out of a trickling filter, every part of the surface must be in working order. This means that freedom from pooling and clean nozzles are essential.

Any clogging of the surface will start pooling which will spread rapidly unless promptly eliminated. Mention has already been made of overcoming surface clogging due to growths by the use of chlorine and bleaching powder. Where surface clogging is due to accumulation of sewage solids, the settling tanks are overloaded or worked at too high a rate, or are dirty. That is to say the sludge is not being removed from the settling tanks promptly enough; or, in the case of Imhoff tanks, solids may be returning from the digestion compartment.

The permanent remedy for this condition lies in attention to the settling tank. If the condition has been allowed to get rather bad, recovery of the filters may be somewhat slow after the tank condition has been corrected and may be hastened by turning over and loosening up the clogged areas. If the clogging is general over the entire surface, or over a large portion of it, a horse-drawn garden cultivator has been found very effective in securing the desired results at very little cost.

If one is unfortunate enough to be burdened with a trickling filter in which the material is too fine, or in which fine material has been placed along with standard-size stone, or in which the stone has disintegrated, the harrow or cultivator will be about the only salvation until such time as new filter media can be obtained.

The useful area of the trickling filter is only that portion on which the sewage can be sprayed directly and can trickle away over the surface of the stone. Therefore it will be seen that it is all-important to keep the surface open and in a drainable condition.

It will also be apparent that to make use of the whole bed area it will be necessary to keep the nozzles clean and working properly. It is not sufficient that the sewage reach the bed through the nozzle. It must be sprayed on so as to reach every part of the bed in droplets.

When we stop to consider that a filter influent having a biological oxygen demand of 100 p.p.m. will require 833 lb. of oxygen gas for each m.g. of sewage treated, we begin to realize that nature must be given every assistance in getting this great quantity of oxygen to the sewage during the few minutes that the later remains in the trickling filter.

The writer has found by experiment that sewage dropped, drop by drop a distance of 3 ft. will pick up a dissolved oxygen content of only 3.4 p.p.m. towards satisfying the 100-p.p.m. demand. When the sewage

was dropped on to a stone surface and allowed to film out over the stone surfaces through 3 in. of stone (1 to 1½ in.) the dissolved oxygen content rose to 4.5 p.p.m.

If we calculate the rate of mechanical oxygen solution for the entire depth of a 6-ft. bed we can account for only 36 p.p.m. towards the 100-p.p.m. demand. Chemical and biological forces, of course, come into play to take on and fix the additional oxygen. The point is that the oxygen must be there and the sewage must be presented to contact with this oxygen over the greatest possible area of stone surfaces. The only stone surfaces which are useful are those directly beneath such areas of the bed surface as (1) are free of pooling so as to permit entry of the air and (2) receive a proportionate volume of the sewage in droplet form so that it will film evenly over the stone surfaces.

▼

New Equipment Installed by Water Company at Carlstadt, N. J.

Equipment which in effect constitutes the elements of a complete water works for a small town and which will maintain service at the highest modern standards and anticipate by several years the water needs of three communities in a growing section of the state has been installed at a cost of approximately $50,000 at Carlstadt, N. J., according to Nicholas S. Hill, Jr., president of the Hackensack Water Co.

Two tanks, with a combined capacity of 1,250,000 gal., connected by booster pumps, have been completed by the company to apply added pressure to the 200,000 gal. of water which pass every 24 hours through the Carlstadt station. By means of this accelerating unit, residents of the high points in Carlstadt, Hasbrouck Heights and Woodridge are assured of water service which otherwise, due to natural pressure limitations, would present a difficult engineering problem.

The three communities are supplied by the Hackensack Water Co., from the pumping plant at New Milford. This water is delivered through some 12 miles of pipe lines, and in the vicinity of Carlstadt enters what is known to engineers as a low-pressure area.

To restore the pressure at this point to the standard maintained by the company, the pipe lines have been conducted into a steel tank nearly 335 ft. in circumference, with a depth of 24 ft. and capable of holding 1,000,000 gal.

Rising 100 ft. above this main tank is another steel reservoir tower with a capacity of 250,000 gal. While the large tank fills by pressure from the New Milford plant, two centrifugal pumps raise this incoming flow to the upper tower, from which it is piped into the mains supplying the surrounding district.

To prevent possible inconvenience to the public, all pumping is done at night. The accumulation of water in the tower supplies the normal needs of consumers for 24 hours and allows the use of the large tank for a reserve supply to cover emergencies.

Installation of the new booster unit has been accompanied at Carlstadt by improvements which make radical changes in property held by the company for more than 25 years. A brick tank which was part of the original equipment has been torn down. Grounds have been landscaped and a section of the plant has been equipped as a waiting room for persons using the bus line which passes the plant.

Hackensack Water Co. Completes New Supply Plant

An engineering transformation wrought in a plot of waste land covering less than six acres in North Hackensack and representing an investment of $150,000 has made possible the centralization of the stores and supplies of the Hackensack Water Co., according to an announcement by President Nicholas S. Hill, Jr.

Work begun a year ago last month among stumps, trees and swamp grass west of Hackensack Ave. is nearing completion in the form of one of the most compact and efficient distribution units devised for the use of a modern public utility, in the opinion of construction engineers who have inspected the plant. The plant has been in operation since July 1, and the finishing touches will be completed in another thirty days.

Economies and improved service to the public over a wide area will result from the new plant, Mr. Hill points out. Within the six acres is centralized a distribution system which formerly was administered in six townships, and so complete has been the concentration of plant and equipment in the present site that the company contemplates disposal of three of the old properties and modification of the service at other points.

Buildings of brick, steel and concrete with a total area of approximately 12,000 sq. ft. from the central unit of the plant. Within the main structure are stored stocks of supplies to meet every emergency of construction, repair and maintenance with which the modern water company deals. These supplies are classified in steel-partitioned sections and arranged according to the frequency of demand. "Fast-moving" stock is nearest the exits, where it is most available for handling and loading.

Within each section, along with pipe, water connections, engines, pumps and other equipment are ranged the fittings which are required with each piece of assembly work. Trucks with crews engaged on construction, maintenance, or emergency jobs pull alongside the loading platforms, file their requisitions and are off again in a fraction of the time formerly required to service such orders.

Outside of the plant, in a large asphalt-paved yard extending toward the New Jersey & New York R. R. tracks, are arranged tiers of the heaviest construction materials. A steel crane, capable of handling weights of 2 tons, is used to load trucks with these materials and also to unload freight cars which are run in from the main line of the railroad on a spur track parallel with the Temple Ave. boundary of the plant.

Under the former system, the unloading of a car of heavy machinery and fittings was an all-day job for four men. By means of the crane and the ease of classification made possible by the new "open air" warehouse, the same crew of four now unloads and stores a carload of materials in less than two hours.

The spur track continues beyond the outdoor storage space and runs the entire length of the warehouse. Materials for storage indoors are set off on loading platforms which practically open directly into the sections for which they are destined in the stock tiers. Trucking of every sort is thus eliminated.

An average of $50,000 in stock will be carried in the new yards, and a system of control has been devised which automatically regulates the amounts on hand. A glance at a tally sheet bearing maximum and minimum stock totals enables the supervisor to keep more than a thousand varieties of equipment up to demand without overstocking any line.

Chemical Handling at the Dalecarlia Water Filtration Plant, Washington, D. C.

Pneumatic Equipment Installed for Handling Bauxite, Alum and Hydrated Lime—System Provides Flexibility of Storage Arrangements—Loss of Materials Prevented and Sanitary Conditions Promoted

IN 1927 the Dalecarlia water filtration plant at Washington, D. C., was constructed by the War Department, under the supervision of the district engineer. A study of material-handling methods resulted in the selection of pneumatic conveying for the transportation of chemicals within the plant, and the Dust Recovering & Conveying Co., Cleveland, Ohio., was consulted for recommendations.

The storage building, square in plan, was divided into nine approximately equal squares, providing eight bins around the center space, which was used for an elevator shaft and stairway. In the tower over the bins space was provided for a pneumatic receiving station, from which incoming material could be discharged to any bin through gravity chutes. The Dracco recommendation was accepted, and the operation of the equipment can be followed from the accompanying diagram.

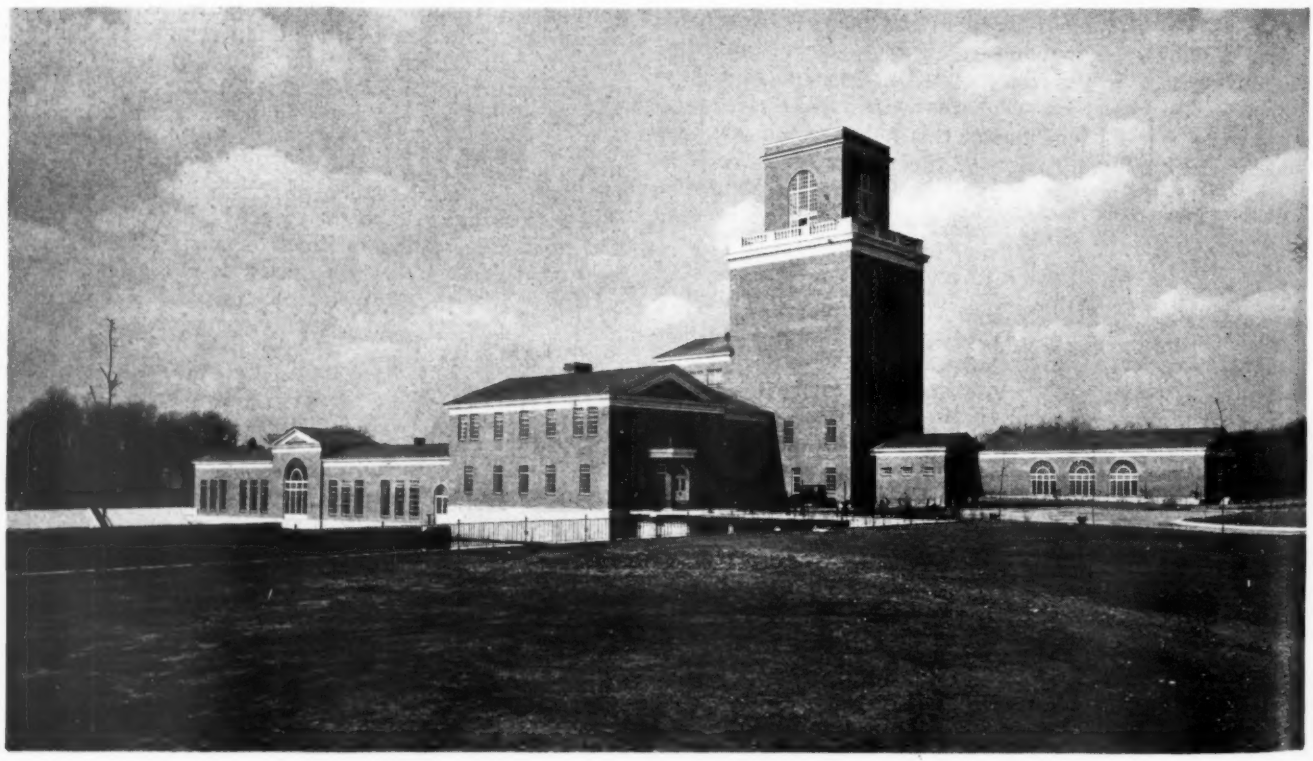
Bauxite, alum and hydrated lime are the bulk chemicals which are conveyed to storage and process by the high-vacuum conveying system. A much larger volume of bauxite is handled than the other chemicals, so the five bins in the two left-hand sections of the storage building are reserved for this material.

The lump bauxite is received by truck, and is dumped into bin, *A*, from which it is fed by gravity to the pulverizer, *B*. The air-separation system carries the pulverized bauxite to the cyclone, *C*, from which the material is conveyed by the high-vacuum system through the pipe line, *D*, to the receiving station, *E*. Discharge either to service bin *H* or to storage bin *I* is provided by the three-gate discharge lock under the receiver, and by the distributor, *F*. From the service bin the bauxite is fed through weigh hoppers to the acid boiling tanks, to produce the required alum.

If it is desired to use bauxite from one of the storage bins, the flexible hose and nozzle, *K*, are connected to the conveying line and dropped into the bin, and the material is conveyed as before to the receiving station, whence it flows by gravity to service. It was originally planned to reclaim material from the storage bins through intake hoppers below each bin, but experience showed a tendency of the material to pack, which made it difficult to maintain a free flow to the hopper. The present arrangement of hose and nozzle is satisfactory and assures free flow from storage bins to service.

To provide an emergency supply of alum, to be used in case of a breakdown in the acid tanks, the center bin in the right-hand section is used for alum storage, with a gravity chute to one of the dry-feed machines, *N*. The lump alum is unloaded, pulverized and conveyed to its storage bin in exactly the same manner as the bauxite.

Hydrated lime is required to neutralize any acid which may be carried over from the settling tanks, so the two remaining bins in the right-hand section are used for this purpose. No pulverizing is required, of course, so the material is dumped from trucks to the platform beside the bin *A*, and is picked up through



Dalecarlia Filtration Plant, Washington, D. C.

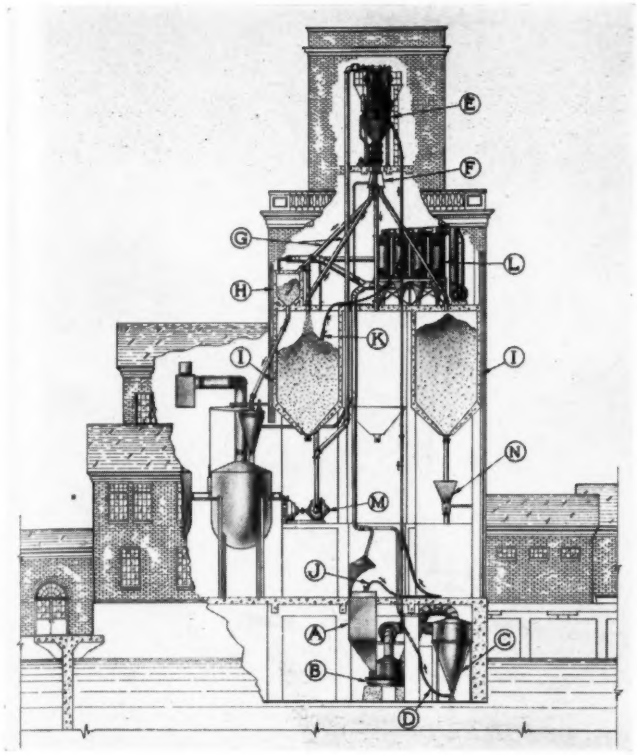


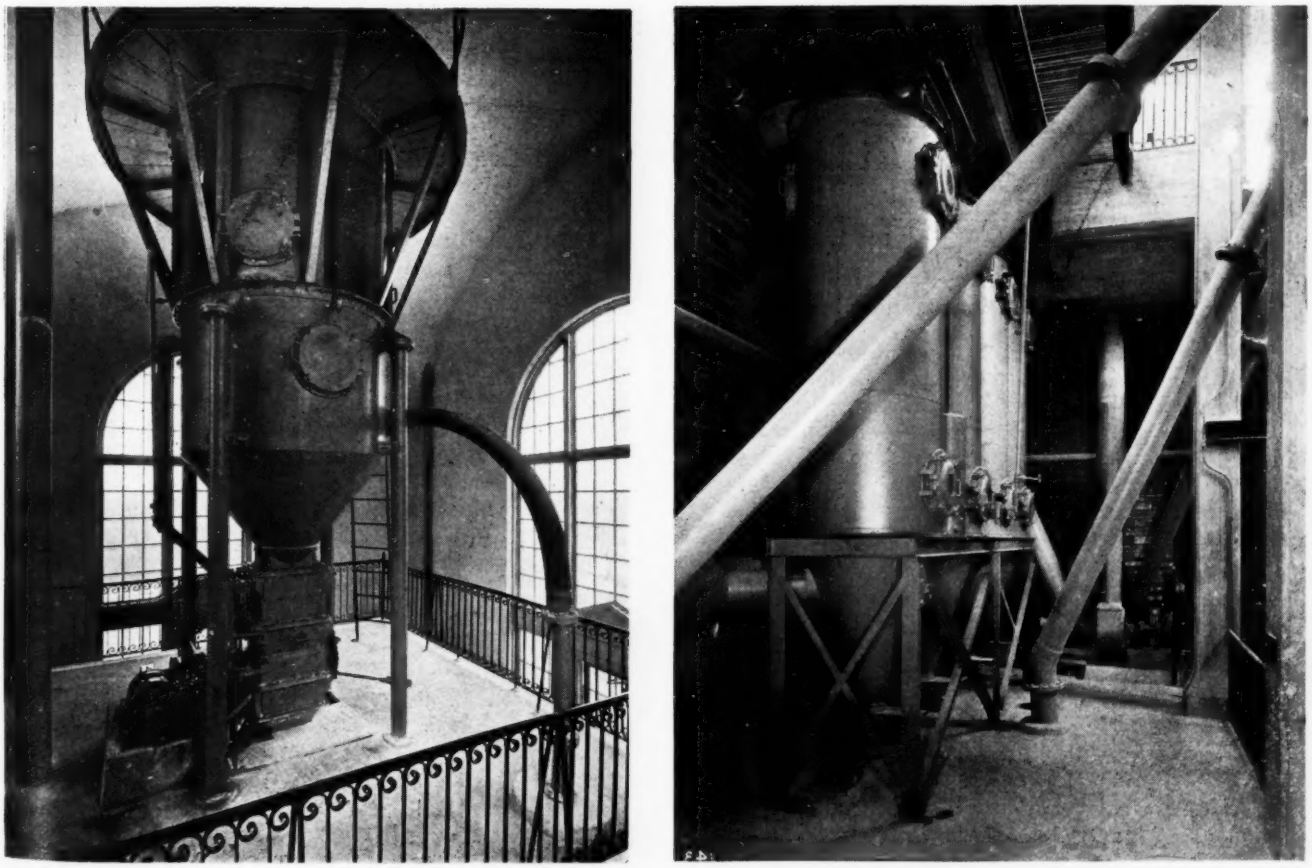
Diagram of Pneumatic Conveying Equipment at Dalecarlia Plant

the intake nozzle *J*. A dry-feed machine, *N*, under one of the bins, provides material flow, and stored lime can be reclaimed from the other storage bin through the hose and nozzle, *K*.

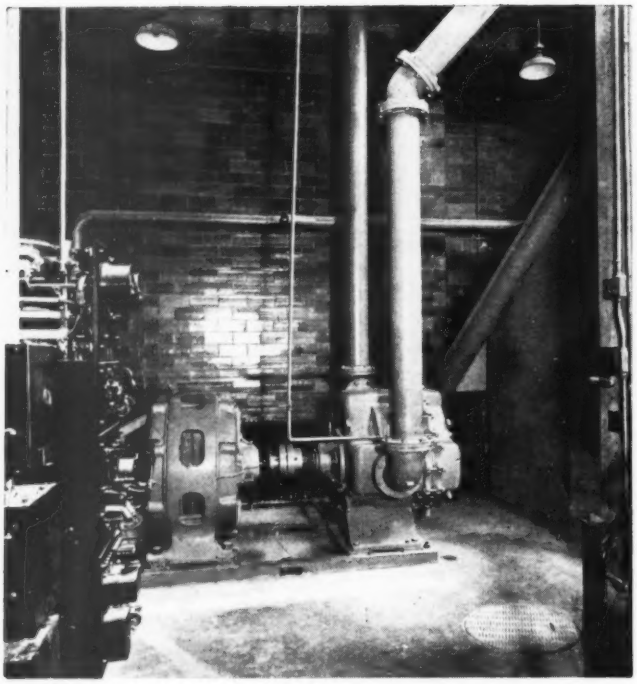
The pneumatic conveyor was installed to handle bauxite only, but the flexibility of the system made it comparatively simple to include the conveying of alum and lime, and all three materials are handled in a completely satisfactory manner. The capacity on bauxite is 10 tons per hour, on alum about 8 tons, and a capacity of 5 tons is secured on the hydrated lime. A 50-hp. motor drives the vacuum pump, which maintains a negative pressure in the receiver of 18 to 20 in. of mercury. The discharge-lock mechanism is driven by a 2-hp. motor, giving a total motor horsepower of 52 for the conveying system.

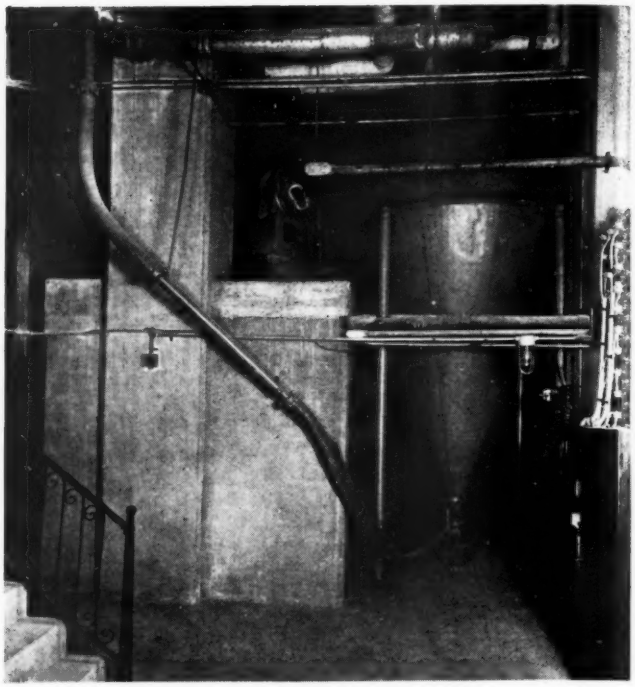
The conveying air, after it has deposited the larger particles of material in the receiver, is exhausted through the three filter compartments which are mounted over the receiver. All the fines are collected on the inside of the filter bags, and discharged automatically by the filter cleaning mechanism, so the exhaust air discharge from the vacuum pump is free from any visible dust. The actual conveying of material is completely dustless, since the piping and receiver are under negative pressure, but there are three sources of dust in connection with the intake and discharge of material. The first is the bin *A* into which the bauxite and alum are dumped; the second, the excess air from the pulverizer cyclone, and the third is the displaced air from the bins which are being filled.

A four-compartment Dracco collector, shown in one of the photographs and at *L* on the diagram, was installed to remove the solids from the dust-laden air which is exhausted from the points of dust origin. A hood over bin *A* provides an inflow of atmospheric air to carry the dust arising from the bin, a connection to the return line from cyclone *C* draws off the excess or vent air and individual connections to each bin provide for removal of displaced air when the bin is being



Left—Collecting Station—"E" on Diagram. Right—Dust Filters—"L" on Diagram





Left—Vacuum Pump—"M" on Diagram; Control Panel at Left. Right—Grinding Cyclone ("C" on Diagram) Showing Intake Hopper Underneath and Conveying Line ("D" on Diagram)

filled. All these lines converge at the filter intake manifold, all visible dust is removed in the self-cleaning bag filters and only clean air is exhausted through the filter fan.

The photographs indicate the neat and sanitary conditions throughout the plant, made possible by the system of pneumatic handling and high-efficiency dust control. The minimum of labor is required, the maintenance cost is low, there is no material loss through dust and spillage and complete flexibility of storage arrangements is assured.

▼

Observations on Filter-Sand Shrinkage

Results Obtained in Detroit Filter Plant by Increasing Filter Wash Rates—Nature and Origin of Forces That Induce Sand Shrinkage Defined

INTERESTING observations on filter-sand shrinkage were given by W. M. Wallace, superintendent of filtration; Roberts Hulbert, senior chemist, and Douglas Feben, of the Department of Water Supply, Detroit, Mich., in a paper presented at the 50th annual convention of the American Water Works Association at St. Louis. An abstract of the paper follows.

The paper is divided into two parts. Part I discloses the results obtained in the Detroit filter plant by increasing filter wash rates on nine filters, from an average velocity of 29 in. per min. vertical rise (producing a sand expansion of 29.5 per cent with wash water at 50 deg. F.), to the maximum obtainable velocity of 34 in. per min. (producing a 36.4 per cent expansion). This increase of wash intensity was made possible by cleaning of the filter sand with lye solution and subsequent hose scour, which process removed 60 per cent of the coating substance accumulated during five years of service. After restoration of the sand to this extent, it was found that the maximum wash could be applied to the beds without loss of sand. One year's trial of the full-velocity wash indicates that (1) re-coating of the sand is greatly retarded and perhaps is entirely prevented, (2) shrinkage of the sand bed with consequent cracking along the filter walls has been greatly reduced, (3) the formation of mud shelves on the gravel against the filter walls, which greatly aggravates horizontal shrinkage, was prevented during the cold water months and retarded throughout the summer, and (4) maintenance of cleaner sand beds by the higher-expansion wash has increased the average filter run by at least 25 per cent. The writers believe that these observations point to the desirability of using a year-around 50 per cent expansion wash to obtain even better results.

Part II gives the results of horizontal loss-of-head measurements made in filter sands undergoing various degrees of shrinkage. The magnitude of the force which must induce divergence from vertical flow through the sand during filtration is thus measured, and is shown graphically. It was found to vary to a considerable extent in different filters, and in proportion to the final degree of shrinkage exhibited by the bed. This horizontal flow component was also found to be greatly aggravated by mud deposits along the filter walls, resulting in correspondingly greater shrinkage.

Since a horizontal loss of head between different locations at the same depth in the sand bed was observed in a perfectly clean filter, the authors now propose a theory to account for the origin of this force, which must tend to induce shrinkage even in a clean bed of sand—something which heretofore, it was thought, did not occur. Briefly, this new theory is that the unequal voids between neighboring sand grains result in variable velocities and correspondingly different pressures in these spaces during filtration, tending to squeeze the sand grains closer together in the direction of the lesser pressure. The effect of this is to decrease the smaller voids and increase the larger, eventual collapse of the sand into the larger voids; the setting up of a new set of strains, and a continuation of horizontal, as well as vertical compacting of the sand mass.

The Duties and Obligations of a Successful Water Works Operator

Qualifications of Successful Operator—Financial Policy—Public Relations—Accounting for Pumpage —Use of Newspaper Publicity—Application of Rate Schedule—Commercial Relations with Users—Collections—Adjustment of Bills—Handling Complaints

By R. H. COREY

Division Engineer, Public Works Engineering Corp., Salem, Ore.

IT will be found in any study of a successfully operated water works that it is managed with strict regard for the comforts and desires of the consumers and the public it serves. The old-time policy of the railroads of the "public be damned" has given way to the modern idea of the "public be pleased." If the management of the present day water works does not please its consumers, then the public does not hesitate in making its opinion known. No management can long continue that does not make its interests entirely those of the people served.

The Personality of an Organization.—Every organization has a personality that is largely a composite of the individual characteristics of those in authority. What the various individuals do, what they say, how they bear themselves in every detail of life, not only of business and public life but often acts of a private nature, have more weight with the community served because discussion of its policies and acts always exists and thus forms public sentiment. The value of an organization reputation is just as great as is that of an individual. Gossip and rumors about it travel just as far in proportion to its individual members, especially when it is a public service organization.

Every water works organization must have character, individual and corporate, supported by candor and courage to demand that the public be fair with it. There is no question that the public is entitled to full information about all water works problems. The management has an equal right to defend itself and demand fair and impartial treatment when its position is sound.

Naturally every organization serving the public is subject to criticism and it should be if it is fair, honest and constructive. If it is wholesome, the water works should welcome it and not take it as a personal affront. However, if criticism be unjust and unwarranted, the management should stand on their rights if they would have them respected. If the policy has been open and above board, then the critic should be, and can be, held to the same standard with no exception or immunity. Occasionally there may be the yelping of some cheap politician whose self-seeking propaganda can be better ignored, but if there is a shadow of truth it must be openly and frankly considered.

The importance of a good name to a water works organization is more essential to its integrity, to its financial credit and to the maintenance of its ability to meet the demands of public service than any other asset. Good name is equally above all riches in private life, or in the group making up an organization. It is a duty and obligation to maintain it for the benefit of the stockholders, or taxpayers, and the public as a whole.

The Qualifications for Successful Operator.—The water works manager or superintendent should be a man of experience and almost perfect in all human qualities. He should not be simply a good fellow, a politician, or a particular friend or relative of someone in authority, but someone in whom not only the management, but the public will have faith in his ability and confidence in his work. The best possible manager or superintendent will very soon have his hands tied, his organization wrecked and permanent harm done to the system unless those over him give him authority, cooperation and only dictate and decide upon general policies of operation, maintenance, construction and finance.

The water works superintendent or manager stands between the group making up his board of directors or water board and the public served. The required qualifications for a successful operator are those of an almost superhuman being. The ideal water works manager or superintendent should be a man who not only has had good training and thorough experience but who understands the public better than the best politician in his city; who understands business economies and financial matters and has progressive business ideas not only for his own work but for the community as a whole. He must not only understand the character of his public but be an integral part of the city, with the aspirations of the various groups that compose it, and be first among those planning for municipal advancement. He must keep absolutely free from religious and political entanglements and maintain always an absolute neutral attitude in all local controversies—all of these, and more, without ever neglecting or forgetting that it is his duty to provide the best water service possible to the whole community.

The manager or superintendent must be versatile. He must be ready to give the same attention to the feminine consumer's complaint of a meter that causes the plumbing to tick like a clock, as to the pressing problems of more water supply. Keeping up collections, reduction of operating expenses, ability to lead and enthuse men, and the thousand and one problems of the everyday routine, requires sound training, practical experience and financial understanding. Instead of being a spender of money, he must be responsible for the spending. It requires an open mind, free from pet theories, willingness to accept changes and suggestions and always ready to subordinate individual ideas to his superior's general policies.

Taking Advantage of Experience of Others.—It is regretted, but it seems to be true, that the average water works manager or superintendent does not make the experiences of others his own to anywhere near the extent that is done in other lines of work. The operators of nearly every water works system have habits and methods of doing their work that are peculiar to that place and which they are convinced are better than any other. Probably no other industry and certainly no

other public service is so bound up in their own ideas and customs. More progress should be made in management methods. This condition may be due in part to the small salaries paid in many places.

Every water works operator who wishes to get ahead and follow the best practice should not only belong to the American Water Works Association but read every worthwhile water works book and magazine published. Personal experiences in handling the many and varied problems are of great value, but whether it is realized or not the discoveries of others are depended upon more. If the knowledge and methods of others are studied regularly and every possible contact made with other water works men, then the operator will not only profit personally but the work will be done in a better and more economical manner.

Definite Financial Policy Essential.—Good management requires a definite financial policy, whether a privately or municipally owned plant. Available revenue, after operation and interest charges are paid, must be applied to a definite construction program. Extensions must not be laid long distances to anyone who wants service, but a definite policy must be followed. The past history of privately owned water works is full of cases where the systems were stretched out so thin, with few customers per mile of main, that when a major improvement was necessary the finances could not be raised. The result of the consequent poor service was municipal ownership. Then the city owned plants have in too many cases allowed the same thing to happen in that the system is extended into new additions of real estate promoters to the point where general tax funds have to pay part, or all, the interest on water bonds.

Water works sell service. It is very largely a matter of transportation of water that nature has provided at the point of collection. Collection, storage, purification and distribution to the consumer's faucet is only a service, for the water itself is free and costs nothing. The consumer does not wish to emulate Jack and Jill but wants pure water in sufficient volume under satisfactory pressure from every faucet at any moment. Water service should be sold, and the idea that it is the sole stock in trade should be "sold" to the public generally.

The dissatisfaction which arises from poor service is one of the most frequent causes of an unfriendly public attitude. The public will overlook and bear with poor service if the cause is properly explained and steps are being taken to remedy it as quickly as possible.

Good Public Relations Vital.—Experience of public utilities has made it clear that good public relations are vital. It is an intangible asset more valuable than any property. There is a growing tendency to give all that possibly can be in service for the income received, instead of getting all possible for what is received. More cannot be obtained in the future unless a willingness is shown to give to the limit. Then the public will have confidence that the management is giving and will continue to give full value.

Never should one promise, half promise, or even hint, that certain things will be done for consumers or prospective consumers until you know and have investigated all the facts. Then an agreement made must be carried out fully and exactly without evasion or excuses. The matter of a service club should be the guiding principal of every water works organization and every individual in it, that "He profits most who serves best."

The Right to Publicity.—The water works utility should, and does, have the right to place before its consumers and the public the facts in connection with its service and business. It should have the same right to publicity as anyone else and should have the same privilege of correcting false and misleading statements. Its right to protect itself from unjust attack should be conceded by everyone. When publicity is pursued fairly, without misleading propaganda, distortion of facts, no concealment or evasion, then only good can result. It is the duty of the water works management, whether private or municipally owned, to take the public fully into its confidence and be made to understand the nature of the business, the cost of conducting it, the effect of governmental restrictions placed upon it, the part it plays in the life of the community and its needs and necessities. Public relations are then better established and the way paved for a sympathetic attitude on the part of the public.

Good-will is receiving more recognition and attention every day. It is one of the chief assets of a water works. If for no other reason than a purely personal, selfish one, the manager or superintendent will find that it pays. Everything possible should be done to promote and maintain such understanding of common aims and interests that will result in cooperation between the management and the public.

It is the common experience of water works men that the public does not understand modern water works, although generally the people are under the impression that it is a simple matter. More public education is needed and then the cooperation and sympathetic understanding of the consumers will be more easily obtained.

Public Relations Are Influenced.—Public relations are influenced more by the opinion and attitude of the employees than most management realize. In the first place, you can, and must, have organization even where there are only a few employees operating a small system. You must respect the organization yourself by not going over the heads of the office manager or foreman except in emergencies or you will soon lose their confidence and cooperation. Have no time or patience for gossip, tale bearing and jealousy, and insist that those under you observe the same rule, for if you do not you will not only have trouble but not hear the many things you really should know. Gossip among employees has wrecked many organizations completely, and the cashier, stenographer, pump operator, or other employee cannot be allowed to continue creating trouble. Public relations begin and end within the water works organization. Time and study is given to purchase of the best materials and machinery to make up the system but seldom is any care used in the selection of the human element that makes up the organization.

Not only must water works employees be competent, loyal and trustworthy but, due to its being a public utility, all employees must be courteous to each other, their superiors and subordinates and especially so to its consumers and the public generally. No amount of suggestion to, or education of, employees will obtain courtesy unless the employees are treated in the same manner by their superiors.

No organization can project good will toward its consumers and the public if there are constant dissensions and jealousies within itself. Some of these troubles can be corrected and should be remedied as quickly as possible without changes in personnel but when no other solution is possible except discharge then do it immediately. Good feeling within is the most important requisite for creating goodwill without. The attitude of employees is often but the reflected light of their superiors.

There is no place for radicals in religion or politics in a water works organization from its top to bottom. Any employees who show a tendency in that direction should be immediately weeded out, for it not only will affect their work but vastly more important will cause the public to criticise your organization. No matter how efficient an employee may be, the hot-tempered, radical or gossip should go at once.

The outer guards of the water works organization are those who daily see and are seen by, know and are known by the consumers and public. The public forms its opinion of the management very largely from its contact with these employees. Other employees who meet the public less frequently have the responsibility of being their guiding spirit to gain the confidence and goodwill of the public. The personal elements of courtesy, promptness, dependability and efficiency are as fully important as good water service. There never was such a thing as a community fully satisfied, individually and collectively, with its water service. A satisfied public is only one that includes so many who have had courteous treatment, a square deal and the best service possible, that the few others make little stir. Every employee should make constant effort to make the latter class as small as possible.

It should be almost needless to say that the first duty of all of those having to do with management, and especially of the manager or superintendent, is to serve only pure water. At all times not only the person in direct charge but every employee must be on constant guard to maintain the water supply in this condition. There is not only a moral responsibility for the health of the community served but a legal and financial liability should the cause of any illness be traced to the impurity of the water supply. A typhoid fever claim in court does not now have to prove that the polluted water served was drunk and actually caused the disease, but only prove that he was a consumer and the supply at that time it was contaminated. It should be needless to say that your supply should be regularly tested as frequently as possible by a competent bacteriologist. Because nothing has ever happened does not mean that constant tests should not be made.

Chlorination Essential.—There is absolutely no excuse for not chlorinating every public water supply. Certainly no water works manager or superintendent can afford to take a chance in not chlorinating the water supply. No matter whether the supply is from wells or other rarely contaminated source and though frequent bacteriological tests are made of the supply, there should be provided this insurance against typhoid fever and other intestinal diseases. The efficacy of chlorination has been completely proven and more than 3,000 cities use it constantly. There is no question whatever in the minds of anyone of chlorination having any injurious effects on the health, or even producing a so-called "drug store" taste even among people who may be prejudiced against dosing drinking water. European travelers drink the poorly made coffee or tea while over there, or possibly may imbide something stronger, rather than to take the real risk in most foreign cities where chlorination is not generally used. Since the cost of chlorination is rarely more than 2 ct. per capita per annum, this expense cannot be used as an excuse for not providing it.

There is no reason for letting chlorination stop for a single minute. Keep enough reserve supply of cylinders of liquid chlorine ahead of use. If the cholrine apparatus becomes out of order, place a cylinder on a platform scale and run chlorine directly into the supply through a piece of garden hose and gauge the dosage by watching the cylinder weight.

The manager or superintendent should know if the rates charged are equitable between consumers and sufficient as a whole to pay all operating expenses, overhead costs and fixed charges. If the existing rates will not pay operation, taxes, if any, and all interests on bonds with an adequate depreciation reserve, then those in charge and the public generally should be made to know of it as quickly as possible. It is not good business or good politics to serve water at less than its actual total cost.

Management should know if the system will meet all the requirements of the Fire Underwriters' standards for a city of its size and building construction. The Underwriters' reports of the system should be studied and plans made to bring it up to standard as early as possible. Not only is there the health obligation of pure water but also the obligation of providing sufficient volume at all times for fire protection. A large part of the investment in a system is required to furnish a large amount of water for a comparatively short time for fire protection.

Accounting for the Water.—The management should know where its water goes. Water works are purely a means of transportation, that is, a means of no longer requiring many Jacks and Jills to go up the hills. If you fall down in the operation of your system and lose a considerable percentage of your water supply before it is delivered to the consumers' meters, you are not doing your duty. Costs of operation are certain to be out of proportion to income. You may say that you have lots of water and a gravity supply system but sooner or later you will pay for the waste in larger mains, additional supply sources, or other related costs.

First, of course, the consumer waste should be cut down by the use of meters on every connection. This is no longer a matter of argument among those informed in water works economics for water taken in excess of reasonable needs is nothing but waste. Only by use of meters can the consumers be assured of paying an equitable portion of the costs of operation, for the user who allows waste of water, or takes more than reasonable needs under flat rates, robs the careful consumer.

The water system that is fully metered should keep its meters in good, regularly tested condition and the system in such tight condition so that at least 75 per cent of the total supply will be accounted for in delivered consumption. The supply main should have a master meter so your daily total use may be known. A great many cities have been able to beat this percentage of leakage and meter slippage.

No system should be without a recording pressure gauge installed on a separate service connection in the business section. The value of a permanent record of pressures is almost obvious. An extra recording gauge should be available for 24 hours test at various points in low pressure areas which after careful study may help in locating a closed gate valve or aid in planning additional feeder mains. All foremen should have a pressure gauge connected to a separate service in their homes, with an electric bell connected so that it will ring whenever the pressure drops below the normal low point, in order that broken mains may be repaired at once. An electric pipe locator should be part of the equipment and if regular use is made of it there will be saved lots of digging for pipe, as well as the injured feelings of property owners whose lawns would have been disturbed. A pipe pusher should be used for

forcing through small pipe in many difficult locations, saving cutting of pavement and lawns.

Newspaper Publicity Valuable.—Not only may relations with the public be very greatly improved but all consumers will have a very much better understanding of the water works serving them if advertising space is used, and all the newspaper publicity in the news columns that can be obtained. It may not be possible for municipally owned systems to expend money for advertising but if constant contact is maintained with the newspapers they will publish not only items that are news but frequently give space for general articles.

The public must be made to understand that good water supply is the first and most important requisite of life, health and material welfare. Water supply is usually not appreciated and is taken for granted. Water is just water to most people until there is a shortage or its quality changes slightly, then most people know exactly what should be done.

Many water works men may think they are too busy to give time to preparing advertising and publicity. It will help solve most of their problems in public relations and decrease operation problems if newspaper space is obtained regularly. It is true that there are no applicances to promote and nothing but water to sell. It is also true you have a monopoly and no competition. However, if the copy in advertising space is changed often and regularly and the items are short, interesting and free from technical terms and involved descriptions, it will be found surprising how much interest is created and the great benefit that will be derived.

Water works publicity should cover general points about water itself, what it is, its composition, mineral content, that is hardness, its purity, why its quality and taste varies, its value to health, industry and for fire protection. It is not only the cheapest public service but the most valuable. Water at its source is free and rates cover only its collection, purification and transportation to the consumer. There are many very interesting facts about water that can be told that will create a real interest in the local water supply.

Publicity can be given to many worthwhile facts pertaining to better use of the supply by the consumer. Waste of water through leaks and its effect on meter bills can be given. Advice on the better use of water for the irrigation of lawns and gardens should be explained in that thorough irrigation once or twice a week produces better results at less cost than sprinkling every day for a short time.

The consumers can be profitably told many facts about the source of supply, the reservoirs, distribution system, filtration, if any or needed, chlorination, pressures, operation, maintenance, extensions, improvements, meters and water rates.

Very valuable assistance can be obtained in putting over worthwhile and necessary improvements with gradual education through the newspapers that if proposals for them were suddenly brought out might cause opposition and misunderstanding. There are always water works problems that, if the public is taken into consideration, will result in gaining their support. Do not wait until immediate action is necessary to tell your superiors and the public of the vital needs.

There is one point in publicity that must never be overlooked. Always give every newspaper in the territory served the same advertising and identically the same news and publicity at the same time if it is expected to retain all newspapers as friends. The best and most valuable friends any water works manager or superintendent can have are the local newspapers.

There are many more or less minor matters connected with the management of water systems. Maintenance is one of the most important of these items. Maintenance that becomes deferred through neglect or lack of funds is one of the most serious problems because it does not have to be cared for immediately as most maintenance requires. The greater portion of the value of a water works is out of sight underground. Therefore, it would seem good management to maintain all buildings, reservoirs, grounds and equipment in the best possible condition. The slogan of "clean up and paint up" is a good one for water works.

No other business or utility is as lax on the whole in not having proper records and especially complete maps of the water works system. There certainly is every reason for the making of complete maps of existing property and in keeping them up to date. These will be of the greatest value in the future in knowing the location and size of mains, valves and services, and future extensions and improvements can be intelligently planned. In this connection, difficulties with old employees may be saved by having adequate maps as it often happens that old employees, because of their sole knowledge of the system, cause trouble.

Application of Rate Schedule.—The correct application of your rate schedule is a very important matter. It is often surprising to find in a study of the details of the various consumers' accounts that the rates are sometimes not correctly applied. There are often cases where special rates and service charges were given and overlooked. Where there are questions that are not clear in your rates, these should be settled definitely and made a part of your rates and rules. You must hold definitely to your schedules for, if not, you may soon have more or less preferential differences that will be difficult to change or explain. Do not make variations or special rates that are not definitely authorized in your rate schedule. The natural tendency of all of such variations, incorrect applications and special rates are to be less than the correct tariff and reduce your income. A careful examination should be made occasionally of the entire consumer's billing to see that the rate schedule is being properly and fully applied. The manager or superintendent should consult his superiors in all rate variations and questions of any consequence for these affect the pocket book nerve of the consumer. If a privately owned plant, then consult with the Public Service Commission to obtain advice or a ruling in the matter.

Direct Relations with Consumers.—Some of the direct relations with the consumers deserve more study and attention of the management than is often given to them, for they tend to strengthen or break down public relations and confidence if not properly handled. First in importance is the cashier who can and must be the good will representative of the whole organization. The cashier must give the final personal touch of good service that all the other employees work for faithfully. Probably not more than 40 per cent of consumers mail checks in payment of their bills in the average system and the cashier faces the balance every month across the counter. Then there are the new consumers who continually are coming in to arrange for supply. What impression is created of your organization? It can be made good by a uniformly cheerful greeting, tactful, prompt, efficient service and a sincere interest in their requirements. The cashier should be one who will gain and hold the friendship and esteem of all. Next in importance are the meter readers and complaint men who come in daily contact with the public. Only employees of good disposition, neat appearance, consider-

able poise and sound judgment should hold such positions. All must positively understand and remember that they will have to stand occasional abuse without retaliating or losing temper for it is seldom caused by a personal matter, but the water companies policies that cause the outburst that may be due to the irate user who may have gotten out of the proverbial wrong side of the bed. The widely advertised business policy that "the customer is always right" is not true in every instance so a polite, firm, unvarying policy must be enforced.

Commercial Relations with Users Very Important.—A new consumer may immediately become a hidden thorn in the side because of some difficulty that might at the moment be considered of minor consequence. Every possible effort should be made to secure a signed contract before water service begins. This means that your service department must promptly shut off the service connection when a user pays a final bill. Where the owner does not pay the water bills and usually the landlord will not tell the tenant, the new user will have ill feeling enough without allowing him to have service for a time and then forcing on threat of shut off to come to the office to arrange for service. Take a sincere, personal interest in the new consumer. This is the point where your acquaintance begins and the first impression is the most lasting. Please the new customer in the initial dealings and you will rarely have an unjustified complaint from him later. It will not take much time in most cases to know something of the newcomer's plans, hopes or aspirations, without being inquisitive.

The old consumer should never be taken for granted. A cheerful greeting and expressions of personal interest only to the extent that is welcomed and absolutely never beyond that point makes for a kindly regard for the company or department.

Guarantee deposits are absolutely necessary to secure payment of bills and requires a fixed policy with but only rare instances of favoritism. Tenants should always be required to make a deposit and owners who are always in arrears. You should have an equally fixed policy of notifying the consumer and refunding the deposit after a fixed period of say one year of prompt payment. By so doing, you will create a good friend and seldom will such a consumer become poor pay afterwards.

Policy Regarding Collections.—Collections are a highly important matter and there must be a rigid unvarying policy in that respect as any other rule. There are, of course, always consumers who are almost an object of charity. Public water supply is almost the prime necessity of city life and only in such cases should leniency be shown, and then only after someone of your organization has verified the conditions. Then there are occasionally commercial and industrial enterprises that become sick financially, who require careful collection consideration. It is better to have ample guarantee deposits from large consumers in the beginning than to be finally forced to take drastic action. Collections should be definitely and strictly made, according to your rules and regulations, and if not so made, continue service only upon a definite promise of payment on a fixed date. The consumer who is allowed to run bills along without payment for several months will almost always forget the accommodation and invent some service complaint when he is finally forced to pay if he does not move away before without notice. There are many forms of business which are of a personal service nature, such as the railroads, public utilities, fuel and laundry, and which the user has nothing tangible to show for it after it is used and human nature hates to pay for the "dirty shirt" or a "dead horse." Do not hesitate to shut off service on account of delinquent bills and enforce it without fear or favor from the mayor or wealthiest capitalist, down to the most humble citizen, for you will gain more friends than you are certain to lose by being lenient.

Adjustment of Bills.—Adjustments of bills are necessary at times and here again a fixed policy must be maintained and strictly observed without favoritism. Insist on its being done in your office and not at the home or place of business of the user for then you will have all the records available. Large bills, because of allowing faucets to run to prevent plumbing freezing in cold weather and because of plumbing leaks, are probably the most frequent cause of claims for adjustments. Have the meter reader check the meter reading and inspect the plumbing for leaks, then refigure the bill for possible error and notify the user as quickly as possible.

It is hardly necessary to say that there should be no free or partially free consumers. Do not allow any that you suspect of obtaining water without paying to continue without thorough investigation. Even with a 100 per cent metered system there should be a systematic inspection of the users in every city block to check the active consumers and vacancies against the office records to see if there are any unauthorized users. Such inspection should be made without any reference to the office records and only checked after the name, address, meter size and number, off or on, well supply and other necessary data are obtained. It often happens that sufficient additional revenue is obtained to pay inspection costs. Particular attention should be given to lost and abandoned service connections that may have been connected up for unauthorized use.

Meter Reading and Testing.—Meter reading variations, causing high or low bills, must be checked every month. The meter reader should be promptly furnished a list to reread and investigate the cause. All large consumers' consumption and bills should be carefully compared every month before mailing with the month before and the same month of the year before. This will show out of order meters and the seasonal use of water by some industries. You cannot afford to lose a considerable part of the revenue from any large user for a month or many months.

A definite time limit meter testing policy should be adopted. Personally, it is believed that in the great majority of cities the meters are not tested frequently enough. The quality of the water and its effect on meters prevents any general rule for every system for meters measuring some waters might be beneficially tested 2 or 3 times as often as in other places. Certainly residential meters should be tested as often as the results in increased revenue will pay the cost of testing and it might be well argued that it would be good business to test large meters even more frequently than this policy would indicate on account of the difficulty and frequent losses in adjusting large out of order meter bills.

Battery meters are favored by the writer for the large consumers in the average small city where equipment is usually lacking to test meters larger than 2 inch in size. A battery of three two inch meters can be installed at the same cost as a 4 inch meter. Then any one of the meters can be tested at less than one-third the cost of the larger meter without service interruptions, for the small system seldom has spare large meters to install, while the meter is being tesetd. Battery meters save claims of less water use while a large meter is off for testing and repairs and usually give

better total registration because of being tested more frequently.

Handling Consumers' Complaints.—The last point to be discussed, but far from being the least, of good management of direct consumer relations is the necessity of prompt and thorough investigation and settlement of consumers' complaints. It is true that many complaints are trivial or imaginary, but everyone is deserving of full and complete investigation. Chronic kickers are more persistent than algae, B coli, or water dogs and they have no distinction in that they cannot be exterminated but can be very considerably corrected and reduced in number. You should get after them immediately upon their first evidence of life and peacefully and politely effect a cure.

You should have a tactful, discreet man who is well informed to handle all complaints, and use forms that will give both you and the one who enters the complaint full information. No complaint should be considered as closed until you have at least a return postal card from the complainant, stating that the matter has been fully and satisfactorily adjusted. The more important complaints should have the personal attention of the manager or superintendent who should consider it his duty to make complete investigation and correction of the trouble.

The manager of a small system should never remain behind a closed private office door but in sight and hearing of the public counter and ready at all times to take any complaint personally. Do not keep anyone with a complaint waiting but give cordial and complete attention immediately. The customer can then tell his troubles to someone in authority. You must wait patiently until the whole story has been told before you ever offer any suggestion or adjustment for if you do not, it may develop into a hot argument and you have entirely lost a potentially strong friend. Should the complainant not cool down, then promise only an immediate and thorough investigation even if it is a matter that could be satisfactorily explained in a few words. Then write a cordial letter, briefly explaining the situation. You can win good will often from a dissatisfied consumer even though you may not do or concede everything desired, if you are careful to be sympathetic and fully explain all the matters involved in the complaint. If you, or anyone in your employ, are partly or wholly wrong say so immediately and explain why and how it occurred. Courtesy, diplomacy, sympathy and patience are absolutely essential qualities in everyone who handles complaints.

Complaints should be always welcomed and never receive anything approaching a sneer. From an operating standpoint, if not for public relations, the consumers should all feel free to tell of any troubles, for how else will you always know immediately of minor conditions such as occasional stagnant water in some deadend mains.

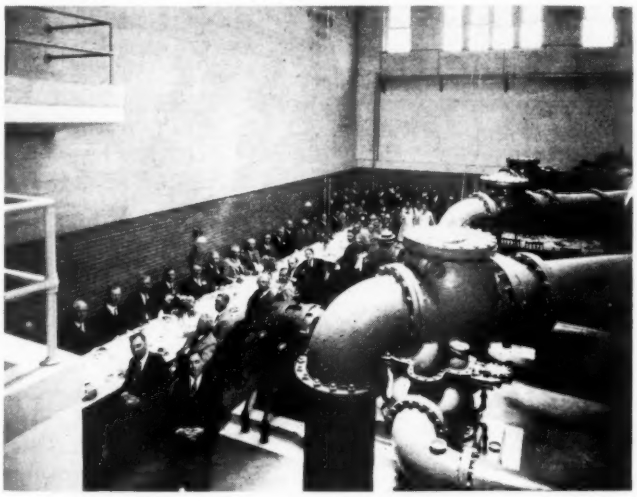
It is a strange fact that the public is predisposed to criticise and be more or less antagonistic toward a public utility whether privately or publicly owned. It is very unfortunate and is a decided handicap that is not encountered to the same extent in private business. This requires that every individual consumer who is dissatisfied, or who has any service trouble, must receive painstaking attention until the complaint is corrected or adjusted on a square deal basis.

Acknowledgment.—The foregoing is an abstract of a paper presented at the Portland convention of the Northwest Section of the American Water Works Association.

Progress in Sewage Works Design

THE accompanying picture, visualizing the progress that has been made in sewage works design, was taken in the pump room immediately adjoining the sewage tanks of the sewage treatment plant of the Aurora Sanitary District, designed by Alvord, Burdick & Howson, Chicago, Ill. The occasion was a luncheon held June 12, the day following the dedication of the plant, during the seventh annual meeting of the Illinois Association of Sanitary Districts, held jointly at Aurora and DeKalb, Ill.

It is interesting, notes Donald H. Maxwell, principal assistant engineer, Alvord, Burdick & Howson, that a portion of the food served at this meal was cooked in



Members of Illinois Association of Sanitary Districts at Luncheon in Pump Room of Aurora, Ill., Sewage Treatment Plant

the plant laboratory with gas from the sewage, generated in the separate sludge digestion tanks. This plant and two others designed by Alvord, Burdick & Howson, generate an average of 0.7 to 0.8 cu. ft. of gas per day per capita of tributary population. The gas generated per ten or fifteen families tributary, is enough to supply the ordinary gas consumption of one family. The gas is used in part to heat the sludge in the separate sludge digestion tanks, thereby promoting the digestion process. The gas averages from 700 to 850 B.t.u. per cu. ft., which is a higher heating value than ordinary gas.

▼

Sanitary Engineers for U. S. Public Health Service

Examination of candidates for commission as Assistant Sanitary Engineer in the grade of Assistant Surgeon in the Regular Corps of the U. S. Public Health Service will be held at Washington, D. C., and other places if necessary, on Oct. 6, 1930.

Candidates must be 23 years and not over 32 years of age. They must have been graduated in engineering at a reputable technical school or college, and have had three years' professional experience since graduation. They must satisfactorily pass oral, written, and practical tests before a board of commissioned officers, and undergo a thorough physical examination.

Request for information or permission to take this examination should be addressed to the Surgeon General, U. S. Public Health Service, Washington, D. C.

Left—Perforated Pipe Awaiting Installation; Right—Dewatering Excavation

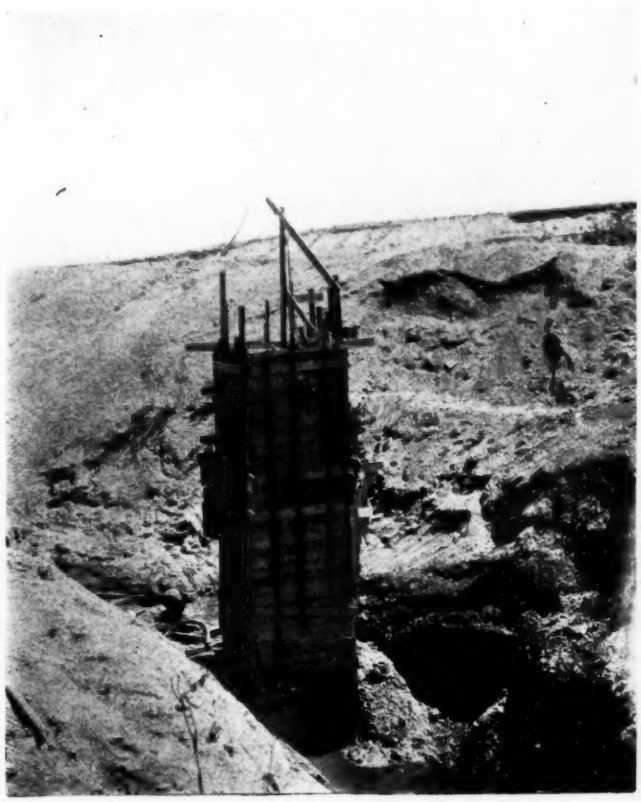
Castle Rock, Col., Builds New Intake

Colorado County Seat Improves Water Works by Extending Infiltration Galleries at Cost of $20,000 —New Intake Placed at Twice Depth of Old Galleries—Corrugated, Perforated Pipe Used

By JOS. C. COYLE

SITUATED at the confluence of Seller's Gulch and East Plum Creek, two streams which are little more than ravines, with a very small flow of water during the dry season, Castle Rock, Col., has long been concerned with the problem of procuring a sufficent supply of water. The town was incorporated in 1881, and a water works system was installed in 1916 at a cost of $65,404 to supply the 500 inhabitants. A concrete storage reservoir, holding 1,000,000 gal., was built on a hill above the town, and wooden infiltration galleries were installed in both the ravines above the town, with 8 and 10-in. wooden pipe leading from the galleries to the reservoir.

Irrigation water rights along the little valley took



Left—Dragline Excavating Trench and Laying Pipe; Right—Manhole Before Backfilling

much of the available water, however, and it was found necessary to extend the intake 2,400 ft. farther up the valley on East Plum Creek this year, placing it at twice the depth of the old galleries. The new installation was completed by Aug. 1, 1930, and cost $20,000.

Excavating, placing the pipe and backfilling were done with a ¾-yd. Marion dragline, the ditch in places being made through a heavy growth of willows, which were removed with the machine. Surface water was bypassed in a temporary ditch. Drainage of the trench was largely by gravity, although a 4-in. centrifugal pump operated by a Fordson tractor was used in dewatering excavations for manholes and a 4-in. diaphragm pump was occasionally used for removing mud by hand. The concrete manholes were installed at angles in the line, and extended 3 ft. below the pipe, acting as sand traps. A little Wonder concrete mixer was employed in pouring the manholes. Hardesty irrigation gates were installed to shut off the flow of water while traps are being cleaned.

Several types of perforated pipe were considered for the intake. That finally decided upon was Armco corrugated culvert pipe. A distance of 1,220 ft. of this is 12-in., 16-gauge pipe, double-riveted and dipped with two coats of hot asphalt. There is 1,210 ft. of similar pipe, also double-riveted and dipped, perforated with ¼-in. holes for 90 deg. of the circumference. This is laid in a single line up through the stream bed, at a depth of 16 to 23 ft. At the upper end a cross-line of 15-in., 16-gauge pipe, treated similarly to that described, and with ¼-in. perforations in 180 deg. of its circumference, will be laid at right angles to the main line, in order to intercept all possible seepage. This line is 400 ft. long, and all perforations are turned up to prevent escape of water once it has entered the pipe.

A strip of clean gravel, 2 ft. wide, was backfilled immediately over the pipe, the first 6 in. on top of the pipe being screened to from ⅜ to ¾ in. in size. This is expected to conduct the slightest flow of surface water to the pipe during the dry months.

Castle Rock is about half way between Denver and Colorado Springs, and is the county seat of Douglass County, one of the first counties organized in the state. It is named for a peculiar rock formation on the top of a small hill near the town. L. C. Tuggle is water commissioner. The Platt-Rogers Construction Co., of Pueblo, were the general contractors on the new installation, and the Wyland Engineering Co. were consulting engineers. John F. Rhoads was resident engineer and C. A. Luce superintendent of construction for the contractors. Pipe was furnished by the R. Hardesty Mfg. Co. of Denver.

▼

Missouri Water and Sewerage Conference Held Oct. 23-25

The sixth annual meeting of the Missouri Water and Sewerage Conference will be held on Oct. 23, 24 and 25, 1930, at Columbia, Mo. Headquarters will be at the Tiger Hotel.

The aim of the program committee this year is to cover the more important phases of water production and purification as well as sewage disposal. More time is being allotted to distribution, pumping and general problems, in conjunction with the important items of water purification and sewage treatment. At past meetings, men having a national reputation in the waterworks and sewage treatment fields have been present; this year will be no exception.

Erosion May Aid the Engineer, Says New Drainage Bulletin

Drainage engineers need to be able to foretell whether silting or erosion will occur in a drainage channel. Conditions may warrant construction of a ditch of inadequate size with assurance that erosion will enlarge it to the required size. This may effect considerable savings. Before the engineer may safely follow such a course, however, he needs very definite information regarding the probabilities of erosion and silting. Technical Bulletin 184-T entitled "Erosion and Silting of Dredged Drainage Ditches," just issued by the U. S. Department of Agriculture, offers information of this character.

The bulletin gives results of measurements made on 22 drainage ditches of various sizes in Mississippi, Tennessee and Iowa, representing several different soil, topographic and climatic conditions. The changes that took place in these ditches over a period of years were carefully determined by means of numerous measurements of their cross-sections. Observers noted carefully the factors that accounted for these changes.

Among the conditions which influence the erosion and silting of a channel, according to this bulletin, are vegetation, caving and sloughing of banks, backwater, variation in water stages, enlargement of the cross-section, silt charge, variations in fall and the volume of the run-off water. The bulletin discusses the relative importance of these various factors.

To show the practical value of the data, the results were applied to the design of a dredged channel in southern Illinois and it was determined that a saving of $43,650 in the cost of excavation could be effected by allowing erosion to enlarge the channel to the required size.

This bulletin may be obtained free, while the supply lasts, upon application to the Office of Information, U. S. Department of Agriculture, Washington, D. C.

▼

Accounted for and Unaccounted Water at Dubuque, Ia.

According to the 30th annual report of the Water Department of Dubuque, Ia., of which John W. McEvoy is superintendent, 74.2 per cent of the total pumpage for the year ending March 31, 1930, was accounted for. Of the total pumpage 63.4 per cent was salable and 36.6 brought no revenue. The following table from the report shows the pumpage accounted for:

	Gals.
Salable Water	636,909,750
General Flush of Distribution System	6,500,000
Flushing 2,120 hydrants at 7,500 gallons each	15,900,000
Extension and plumbers' ditches	2,000,000
Service leaks, 136 at 100,000 gallons each	13,600,000
Six hydrants broken (30 min. at 1,000 gallons each)	180,000
Cleaning Level Reservoir (3 times)	1,500,000
Draining West Third Street Reservoir	4,000,000
Known leakage in W. 3rd St. storage reservoir—(24,000 gallons per day)	8,760,000
Meters tested at 35 gallons each	200,000
Eagle Point Station	2,000,000
By-Pass from Low Pressure to Level Reservoir	2,592,000

	Gals.
Flushing city streets and sewers	25,000,000
Two horse fountains and 8 bubblers	8,800,000
Fire Department	8,500,000
City Parks (120 days at 10 hrs.)	3,000,000
Bathing Beach and Athletic Field	1,500,000
Ice Rinks (7)	4,500,000
Free Water Furnished the City	51,300,000
Total Number Accounted for	745,441,750

Water Works and Sewerage

Published Monthly by
GILLETTE PUBLISHING COMPANY, 221 EAST 20TH ST., CHICAGO
Publishers of

Roads and Streets
Engineering and Contracting
Water Works and Sewerage
Motive Power
Tiles and Tile Work

Motor Freight
Road and Street Catalog and Data Book
Water Works Catalog and Data Book

HALBERT P. GILLETTE.....President and Editor
E. S. GILLETTE.....Vice-Pres. and Secretary
E. B. HOWE.....Vice-President
E. C. KELLY.....Vice-President
T. F. KILROE.....Vice-President
J. M. ANGELL, JR.....Eastern Manager
C. T. MURRAY.....Managing Editor
VICTOR J. BROWN.....Associate Editor
CHARLES M. NELSON.....Associate Editor
J. R. BAYLIS.....Associate Editor
J. R. DOWNES.....Associate Editor
L. H. ENSLOW.....Associate Editor
H. J. CONWAY.....Make-Up Editor
L. R. VICKERS.....Distributor News Editor

Cleveland Office.....953 Leader Bldg.
New York Office.....420 Lexington Ave.
San Francisco Office.....703 Market St.

Subscription Price $2.00 Foreign Postage 65c Extra

Copyright, 1930, by Gillette Publishing Company

A Rain Cycle of 29.56 Days

RAIN cycles of about 2 weeks have been frequently mentioned by meteorologists. Clayton, in "World Weather," attributes that cycle to sun spots; for in the latitudes of most numerous sun spots the sun rotates in about 27.3 days as viewed from the earth, and sun spots are usually most numerous about 180 deg. apart in longitude. This would result in a rain cycle of about 13.7 days. While such cycles can be found, they are not persistent. This lack of persistence led the editor to infer that, while the sun's surface rotates in about 27.3 days in the sun spot region, there is a different rate of rotation below the sun's surface. Investigation disclosed a sun spot cycle of about 29.5 days (*Engineering and Contracting*, February, 1929.)

Following up this clue, a search was made for a rain cycle of about 29.5 days, and Juneau, Alaska, was selected as the first place to investigate.

The daily rainfall at Juneau during the years 1917 to 1929, inclusive, was tabulated by the periodogram method, at first using a period of 29.5 days. This disclosed a rain period slightly longer, and it was found that a period of 29.56 days fitted the facts so well as to leave no doubt as to its substantial accuracy. The periodogram disclosed that this main cycle is divisible into 6 sub-cycles of practically equal length, or nearly 5 days each. These sub-cycles are very marked, not only on the curve of averages covering the entire 13 years, but on curves based on data embracing only 2 years. Of the sub-cycle peaks, those occurring at intervals of about 15 days are most pronounced. A recent rain peak at Juneau was July 14, 1930.

At Los Angeles the rainfall peaks occur about 3.5 months later than at Juneau. This is true, not only as to the average annual maximum, which is early in October in Juneau and in the latter part of January in Los Angeles, but it is true of many individual storm peaks. This "lag" may be attributed to the effect that the 24 deg. difference in latitude produces; for it can be shown that if the axis of an electron-whirl on the sun is in a position to produce a maximum magnetic uplift of an electron-whirl near Juneau, that same solar electron-whirl will produce a maximum uplift of an electron-whirl in the upper air at Los Angeles about 3.5 months later. Intermediate points show less "lag," depending on their latitude.

The existence of rain sub-cycles of 1/6 x 29.56 days indicates that the sun has permanent electron-whirls located 60 deg. apart in longitude. In this respect it resembles the earth, for the earth has three permanent barometric "highs," in each of the two tropics, and presumably as many permanent "lows" near the two poles. Photographs of Jupiter show circular spots near its equator, longitudinally spaced about 30 deg., center to center; Jupiter causes a rain cycle that averages 1/12 x 11.2 years (11.2 years being the length of the sunspot cycle due to Jupiter), or 11.2 months. An 11-month rain cycle has been noticed by many meteorologists. We find that there are, in fact, two cycles of about 11 months, one of 11.2 months, which is a Jupiter sub-cycle, and one of 10.91 months, which is an Earth cycle.

That there are certain solar longitudes where sun spots tend to originate was shown many years ago by Wolfer, but, misled by the belief that the basic rotation period is about 27.3 days, he failed to find that these sun spot longitudes are permanent. Untermeyer found a sun spot cycle of 29.4 days, but his discovery has been so completely ignored by writers that it did not become known to the editor until after he had found a sun spot cycle of about 29.5 days. A more extended study of sun spots now shows that cycle to be 29.56 days, corresponding with the rain cycle.

While sunspots unquestionably cause rainfall at times, the six permanent electron-whirls on the sun are more productive of rainfall, because they cause rain when there are no sun spots.

Due to the "lag" between rain peaks at Juneau and at places to the south, Alaskan rain peaks can be used to forecast those at points to the south. In 3 out of 4 cases a heavy rain peak at Juneau has been followed by one at Los Angeles 105 $\pm$ 3 days later during the past three years.

The Chinaman's Linguistic and Arithmetical Handicap

AS a youngster the writer often watched a Chinese laundryman calculate the bill for the "wash," using for the purpose a "swanpan." This abacus had beads threaded on horizontal wires, along which they could be slid. Lacking knowledge of Arabic numerals, the laundryman had to use this primitive device. Even more primitive were his written symbols, being in fact but a crude development of pictorial writing.

It is difficult for us to appreciate the arithmetical and linguistic handicap under which the Chinese exist. Not only is almost the entire literature of pure and applied science closed to a man who does not understand an alphabet, but even were he possessed of that knowledge still he could make scant progress were he not also acquainted with the system of Arabic numerals. Consider how far you would have progressed in scientific knowledge were you able to compute only by the aid of an abacus.

Even as the average Chinaman is now mathematically handicapped, so were almost all Europeans handicapped until about 450 years ago. The first printed arithmetic appeared in Italy in 1478, the first in Germany in 1482, the first in England in 1522, the first in America in 1719.

It is true that the Arabs had learned the basic features of their numerical system from the Hindus about the year 800, and that Arabic arithmetic became known in Christian Europe about 400 years later; but no wide-

spread knowledge of this system occurred until the printing press was invented.

The use of the zero, which gives place value and is therefore the most important part of the so-called Arabic system, is first found in an Indian land grant of 738 A. D. Some unknown Hindu genius had finally hit upon a place system advancing by multiples of 10; and by that single change had revolutionized the whole art of computation.

The next great step was the introduction of decimal fractions, which was in 1585 by Simon Stevinus, the Dutch genius who discovered the hydrostatic paradox that the downward pressure of a liquid is independent of the shape of the vessel and depends only on the area of the base and the height of the liquid. He conceived the idea that the tides are due to the moon.

To a Scotchman, John Napier, the world is indebted for the next great invention in the art of computing numerically, namely logarithms. In 1614 he published his remarkable work containing the first logarithmic tables by which multiplication became merely a process of addition. That book has been regarded by many as second only to Newton's "Principia." Perhaps the most remarkable feature about this great mathematical invention is the fact that Napier deliberately set out to simplify multiplication and division at a time when algebra had not yet advanced to the point where multiplication was performed by adding exponents. By the aid of arithmatic and geometry, and with no aid from algebra, Napier accomplished his purpose. Slide-rules are mechanical substitutes for printed logarithms.

The vast majority of Chinamen still remain ignorant of alphabetical writing and Arabic computation. Need we wonder at their racial backwardness, in spite of great natural intelligence? Continually they writhe under the tortures of poverty, periodically they starve by the millions, and blame their sufferings upon everything but their own ignorance.

Engineers Lack the "Centered Mind"

IT is hopeless to argue with a strongly prejudiced man. It is foolish to quarrel with one. We shall neither argue nor quarrel with the writer in *The New Republic*, who says: "There is an obvious lack of centered minds in our civilization today; and there is nothing in the tradition of the engineer that will bring them into existence. But until such minds come into being our civilization may be easily ruined by its colossal powers, and victimized by the machine's benefits." This is the closing explosion of an explosive person, in a review of "Toward Civilization," written as a symposium by certain well known engineers.

With some small measure of pride the authors of "Toward Civilization" point toward the achievements of engineering. With a great measure of sarcasm the reviewer says that engineers "combine the chivalry of a Bayard with the intellectual resourcefulness of a Faraday," and admit the combination. Then, casting aside the rapier of sarcasm for the bludgeon of invective, the reviewer says, "If he (the engineer) is as powerful as he asserts, he must take his share of the responsibility for the raucous defects of current industrial society, but if he is just a hired mercenary, he should not boast too loudly of his mastership. . . . They take comfort for our present failure by their charming ignorance of the past; and they bid us look hopefully toward a future which they give us no genuine ground for welcoming; since, unless a quite different order of intelligence comes into existence from that which they complacently exhibit, the future will too closely resemble what is behind."

This last sentence leads us to suspect that its writer is himself not conversant with at least some part of past history; such, for example, as that the British annual average wages remained practically stationary in buying power between the years 1300 and 1800, and then increased four-fold in the first century of the existence of engineering as a recognized profession. We do not imply that this great increase in real wages in Europe, and the even greater increase in America, is to be attributed entirely to engineers, but we do insist that pure science combined with applied science, impelled by the urge for personal profit, fully accounts for this startling emergence from the thralldom of hand-to-mouth existence that had previously been the common lot.

"One wants, first of all, to know if the engineer realizes what his origins are. Is there any notion among these distinguished contributors, that their art has as its social foundation the destructive occupations of mining and warfare?" asks the reviewer, and answers promptly, "None whatever." It so happens that he is accidentally right in this answer, for there is not the slightest historical evidence that engineering originated either in the mines or on the fields of battle. You can find such statements in some encyclopedias, where doubtless the reviewer learned what he thinks he knows about engineering. But suppose it were true that engineering began as a military art, what of it? Suppose iron was first made for use in spears and arrows, does its initial use affect its present value to mankind? If we may revile the man of today because of what some ancestor did, how many of us would escape contumely?

Speaking of the origin of things, almost every treatise on the science of probability says that its first laws were discovered in an effort to assist gamblers to bet more judiciously. Astronomers tell us that astronomy had its origin in that form of quackery called astrology. If so, these add but two to the many examples of the evolution of admirable things from germs that were not admirable.

Our reviewer, as above quoted, speaks of the "centered mind," and although he got that expression from Emerson, we think a better one might have been used; for just when and how is a mind "centered"? Said Emerson: "In a centered mind, it signifies nothing how many mechanical inventions you exhibit." Since Emerson evidently used the word "centered" in a peculiar sense, we must infer his meaning. He means a mind of the sort that sees no great merit in railways, motor cars, airplanes, typewriters, telephones, moving and talking pictures, harvesters, rock crushers, concrete mixers, pumps, sewing machines, vacuum cleaners, dynamos and motors. And it is but a step from this inference to the conclusion that a "centered mind" lacks admiration of all the discoveries in pure science that preceded and made possible these mechanical devices.

Our reviewer charges engineers with lacking the "centered" type of mind. It is as if he had charged a bird with lacking fins. From such centering of intellect as he admires we certainly are free. Life for us does not approach sublimity through idle speculation or ceaseless talk, but through creative action. To us it seems great to be able to understand the greatness of nature and to rival her mechanism even though our understanding be but partial and our rivalry but feeble.

H. P. Gillette

Convention of New England W. W. Association

THE annual convention of the New England Water Works Association will be held at Atlantic City, N. J., September 23, 24, 25 and 26. Convention sessions will be held at the Haddon Hall Hotel. The program, as announced by E. Sherman Chase, chairman of the Program Committee, follows:

TUESDAY, SEPT. 23

Forenoon—Registration, opening addresses, etc.

2:00- 2:45 p. m.—Committee reports.

2:45- 3:15 p. m.—"Disinfection of the Wanaque Aqueduct" by Attmore E. Griffin, analyst, North Jersey Water Supply Commission.

3:15- 3:45 p. m.—"Recent Developments in Chlorination" by Francis D. West, manager of sales, Paradon Manufacturing Co., Arlington, N. J.

3:45- 4:30 p. m.—"The Flow of Water through Corroded Service Pipes" by Gordon M. Fair, professor of sanitary engineering, Harvard University, Cambridge, Mass.

4:30- 5:00 p. m.—"How Small Cast-Iron Pipe Is Made and Used" by J. R. McWane, president, McWane Cast Iron Pipe Co., Birmingham, Ala.

9:00 p. m.—Reception and dance at Haddon Hall Hotel.

WEDNESDAY, SEPT. 24

Special train leaving Pennsylvania Station, Atlantic City, arriving at Florence, N. J., at 10:30; leaving Florence at noon, arriving at Burlington approximately 12:15; luncheon at Burlington, followed by inspection of U. S. Cast Iron Pipe and Foundry plant; leaving Burlington about 3:00 p. m., arriving Atlantic City 4:30.

Afternoon—Ladies' card party at Haddon Hall.

THURSDAY, SEPT. 25

9:00- 9:30 a. m.—"The Atlantic City Water Works" by Lincoln Van Gilder, engineer and superintendent, Atlantic City.

9:30-10:00 a. m.—"Copper and Health" by William G. Schneider, of the Research Department of the Copper and Brass Research Association, New York, N. Y.

10:00-10:30 a. m.—"Modern Aspects of Color Removal" by A. S. Behrman, chemical director; R. H. Kean, research chemical engineer; and H. Gustafson, chemist, International Filter Co., Chicago, Ill.

10:30-11:00 a. m.—"A New Development in Wrought-Iron Pipe Manufacture" by Dr. James Aston, consulting Metallurgist, A. M. Byers Co., Pittsburgh, Pa.

11:00-11:30 a. m.—"The Submarine Pipe Line between Portland, Me., and Great Diamond Island" by Harry U. Fuller, chief engineer, Portland Water District, Portland, Me.

11:30-12:00 noon—"The Story of Anaconda," a moving picture dealing with the production of copper pipe from mine to consumer.

2:00- 2:30 p. m.—"The General Water Supply Situation of Northern New Jersey" by Morris R. Sherrerd, chief engineer, State Water Policy Commission, Newark, N. J.

2:30- 3:45 p. m.—"The New Wanaque Water Supply" by Arthur H. Pratt, consulting engineer, Newark, N. J.

3:45- 4:15 p. m.—"Methods Attempted for Prevention of Phenol and Other Tastes in Water Supply at Rahway, N. J.," by Mortimer M. Gibbons, water-works chemist, Rahway, N. J.

9:30 p. m.—Smoker at Haddon Hall.

FRIDAY, SEPT. 26

Business meeting.

Exhibits.—A feature of the convention will be the exhibits of manufacturers. The list of exhibitors includes the following:

Paradon Mfg. Co.
National Tube Co.
Neptune Meter Co.
The American City
R. D. Wood & Co.
Union Water Meter Co.
Hersey Mfg. Co.
Bingham & Taylor Corp.
Leadite Co.
Simplex Valve & Meter Co.
United States Pipe & Foundry Co.
Ross Valve Mfg. Co., Inc.
Hydraulic Development Corp.
A. P. Smith Mfg. Co.
American Brass Co.
McWane Cast Iron Pipe Co.
Lock Joint Pipe Co.
George A. Caldwell Co.
Pittsburgh Equitable Meter Co.
Chicago Bridge & Iron Works
Lead Lined Iron Pipe Co.
Atlas Mineral Products Co.
Rensselaer Valve Co.
Public Works
Wallace & Tiernan Co., Inc.
Water Works Engineering
Central Foundry Co.
Cement Lined Pipe Co.
Gamon Meter Co.
Worthington Pump & Machinery Corp.
Phoenix Meter Corp.
Pardee Engineering Co.
Gillette Publishing Co., publishers of WATER WORKS AND SEWERAGE
Engineering News-Record
Pittsburgh-Des Moines Steel Co.
Kennedy Valve Mfg. Co.
Pitometer Co.
Builders Iron Foundry
Eddy Valve Co.
Badger Meter Mfg. Co.
Warren Foundry & Pipe Co.
National Meter Co.
Red Hed Mfg. Co.
Vogt Brothers Mfg. Co.
Ford Meter Box Co.
Norwood Engineering Co.

Haddon Hall Hotel, Headquarters of N. E. W. W. A. Convention

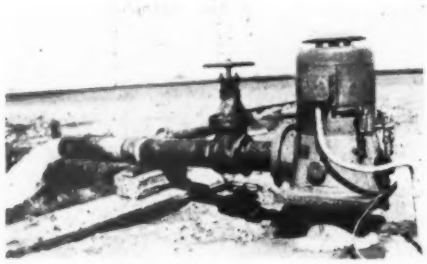
New Equipment and Materials

Timken-Equipped Wintroath Deep-Well Pump

Wintroath Pumps, Ltd., of Alhambra, Calif., has recently announced a new line of anti-friction bearing-equipped deep-well turbine pumps that have several interesting points. The line includes pumps of capacities ranging from 25 to 6,000 g.p.m. and the ratings range from 3 to 400 hp. The standard pumps are directly driven by an electric motor, but they may be modified for belt drive by gasoline or oil engines. The line is especially suitable for work on irrigation systems, municipal water-supply systems, industrial water supply, or domestic systems such as farms, private estates, and similar cases. They can be used on either shallow wells, or those exceeding 500 ft. in depth, where the internal diameter of the well is 6 in. or over. In addition to lifting they may be used as boosters against any desired pressure above ground.

The construction is quite simple, the pump consisting of two main parts, the head, and the impeller mechanism, or pump proper. The former consists of a cast-rotor squirrel-cage vertical-type induction motor, which is connected to the impeller mechanism by a sectionalized line shaft. The motor is designed for across-the-line starting, so that the control consists simply of a start-and-stop push-button station that can be located at any convenient point. The weight of the motor rotor, shaft and impellors is carried by a Timken thrust bearing mounted on the lower end of the rotor shaft. Another anti-friction bearing is used as a guide bearing at the upper end of the shaft. One of the interesting features of the head is the lubrication system that has been adopted. There is an oil bath or reservoir surrounding the Timken thrust bearing, and located so that it extends downward into the discharge chamber of the head. Thus the oil is kept at constant temperature by the cooling action of the discharged water. Oil from this reservoir is pumped to the upper, or guide bearing, whence it flows back to the reservoir. This continual circulation of cool oil not only prevents any possibility of overheating, but greatly lengthens the effective life of the lubricant.

The head is connected to the pump by a line shaft consisting of 10 or 20-ft. sections of Cumberland turned and ground shafting coupled together. It is carried in phospher-bronze line-shaft bearings spaced about 6 ft. apart. This construction makes it a simple matter to lower the pump to follow a retreating water level. The pump proper is of the multi-stage centrifugal type, totally enclosed. The impeller is both hydraulically and dynamically balanced, and extra long bearings have been provided. The intermediate castings, which make up the stages, are equipped with replaceable bronze bushings at the point where the impeller shaft passes through them. The pump is provided with a suction strainer consisting of galvanized half-round wire wound flat side out around a conical steel framework. The construction is such that gravel or similar foreign matter cannot lodge in the openings. Suction pipe can be furnished in any desired lengths.

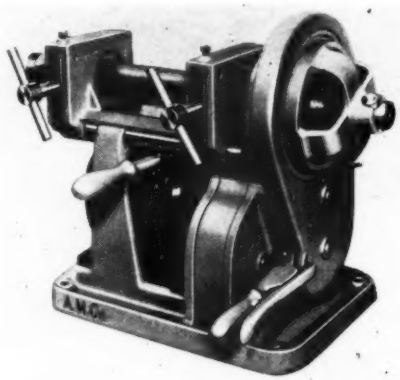


Wintroath Deep-Well Turbine Pump Directly Driven by Electric Motor

▼

New Pipe-Threading Machine

A new pipe-threading machine, designed for a wide range of uses, has been developed by the Axelson Mfg. Co., Ltd., Los Angeles, Calif. Its operation is simple and the machine occupies a minimum of space, according to the manufacturers. The pipe that is to be threaded remains stationary while the standard square die is revolved, cutting the thread. This differs from many other types that require revolving of the pipe. Long stands of assembled pipe or bent pipe may be conveniently threaded as it is unnecessary to rotate the units. The work is gripped by two jaw chucks which are practically automatic and instantaneous in action. Standard square dies, obtainable from practically any supply house, are readily adapted to the cutter thread. Threads can be cut on material from ½ to 2 in. in diameter and the power is supplied from a ½-hp. compound-wound motor, installed directly beneath the pipe-holder brackets. Electric current of 110 or 120 volts, either 50 or 60-cycle, may be applied.

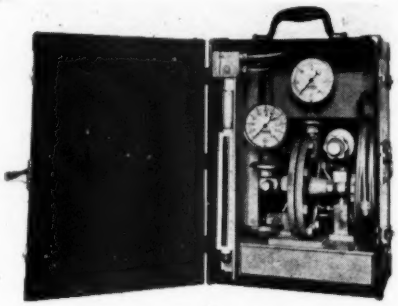


New Axelson Pipe-Threading Machine

The manufacturer claims that the threader will cut at the rate of 17 r.p.m. on all sizes from ½ to 2 in., and the required time for completing 11 threads is about 40 seconds. After the thread is completed the dies are reversed, and during this operation rotate at 34 r.p.m. Attachments are available for the cutter head to permit cutting off, reaming and bolt making.

A New Portable Ammoniator

The Paradon Mfg. Co., of Arlington, N. J., has recently developed a portable ammoniator. The apparatus consists of a standard Paradon Type ADB ammoniator, housed in a fiber carrying case and resembling a piece of hand luggage. The portable ammoniator is adapted to continuous regular use as well as emergency use, as it is designed to do anything that any ammonia-control apparatus will do.



Paradon Portable Ammoniator

In design, it is essentially like the familiar type of Paradon chlorinator except that the parts are made of material that will withstand the corrosive effects of ammonia. A shut-off valve is provided to keep moisture and foreign material out of the apparatus during periods of non-use. No water supply is necessary for its operation, the ammonia gas being applied directly.

The apparatus can be supplied for any range of capacity from 1 to 300 lb. of ammonia per 24 hours. Equipment can also be supplied that would decrease the minimum capacity to 0.05 lb. of ammonia per 24 hours.

The use of ammonia in connection with chlorination of water supplies is spreading rapidly. Many of the applications of ammonia are temporary and seasonal. It was for taking care of this type of ammonia application that the Paradon type ammoniator was developed.

▼

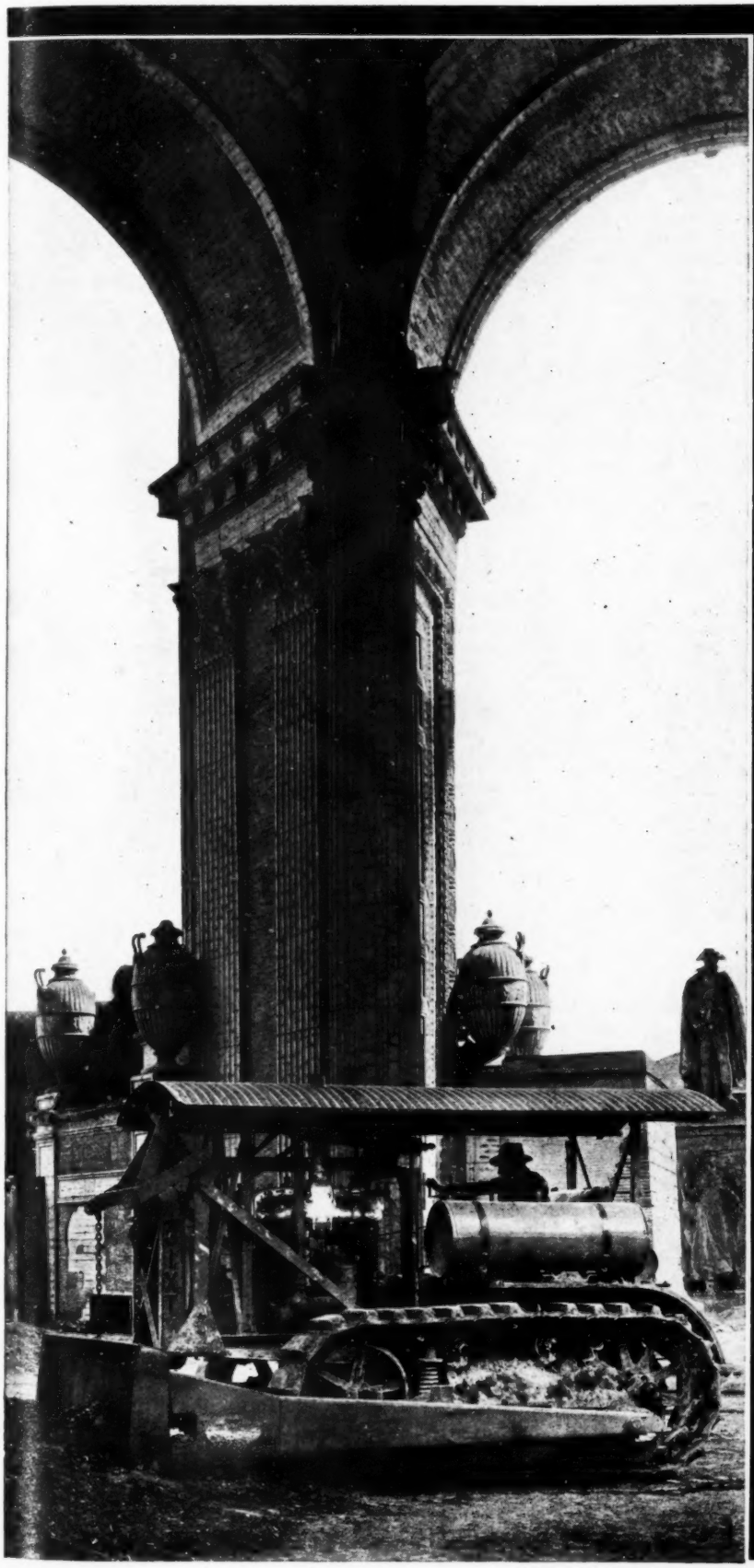
New Sealing Compound

The Quigley Co., Inc., New York, N. Y., manufacturers of Hytempite and Triple-A protective coatings, announce the manufacture of a plastic, expansive compound for sealing joints, called Q-Seal.

A micaceous mineral having expansive properties is ground to a very fine mesh and used as the principal pigment in the compounding of Q-Seal. The principal vehicle or mixing agent used is one that is impervious to crude oils, all of their derivatives, acids, etc., and is non-corrosive.

Q-Seal is easily applied to joints to be sealed with a brush. The expansive qualities fill any imperfections in threads, flanges or gaskets. The compound seals joints leakproof, and prevents rust and corrosion.

PARKS . PLAYGROUNDS, or GOLF COURSES



A "CATERPILLAR" TRACTOR, once it's bought and put to work, lends willing power to scores of tasks. Many cities keep their "Caterpillars" busy the year 'round—snow plowing in winter, building roads, improving parks, leveling garbage dumps and doing jobs of all sorts. The picture shows a Sixty and bulldozer operated by San Francisco's park system.

Prices—f. o. b. Peoria, Illinois

TEN . .	$1100	TWENTY	$1900
FIFTEEN .	$1450	THIRTY .	$2375
SIXTY			$4175

Caterpillar Tractor Co.

PEORIA, ILL. *and* SAN LEANDRO, CAL., U. S. A.

Track-type Tractors Combines Road Machinery

(There's a "Caterpillar" Dealer Near You)

CATERPILLAR
REG. U. S. PAT. OFF.
TRACTOR

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Yeomans Brothers to Test Cooperative Plan

With a view to stabilizing employment, reducing operating costs, securing improvements in design and quality of products, and better operating conditions Yeomans Brothers Pump Company and representatives of the International Association of Machinists met in conference and adopted a systematic plan of cooperation which will enable the employees to share in the resulting gains.

The system agreed upon between the union and the management of the manufacturing organization is similar to the famous plan in operation for some years on the Baltimore and Ohio Railroad. Otto S. Beyer presented the proposals of the International union in the negotiations for a plan. Mr. Beyer was the consulting engineer who was active in developing the plans for the employees' participation in use in the Baltimore and Ohio and Canadian National Railways systems.

The formal acceptance of the plan is said to mark the first time such a scheme has ever been introduced in a factory of this size, although it has won renown on large-scale operations. The fact that Yeomans Brothers has operated on a union basis for more than twenty-five years is given as one of the factors making possible the successful adoption of the plan.

Yeomans Brothers Company, located in Chicago, are well-known manufacturers of sewage ejectors and pumping machinery.

Byers Closes Hand Puddle Mill

The Girard, Ohio, hand puddle mill, operated by the A. M. Byers Company, and said to be the largest single unit of hand puddle furnaces in the country, was recently closed. The discontinued Girard plant was built in 1908, and, in addition to 88 puddle furnaces and the plate mill, included a blast furnace which was dismantled in 1929.

In anticipation of the opening of the new mill which this company recently completed on the Ohio River just outside of Pittsburgh, plans have gradually been going forward for the consolidating of the manufacture of wrought iron in the Pittsburgh district. In comparison of the Girard's plant capacity of 5,000 tons a month, the new mill is expected to have a capacity of 45,000 tons a month.

It is stated that, according to United States Bureau of Standards, the wrought-iron produced by the Byers' new process has a highly refined base iron and uniform distribution of iron-silicate. With the new process now in operation Byers is enabled to manufacture wrought-iron on a scale which permits them to roll plate for pipe directly from the billet instead of piling and re-heating much bar. It is stated that pipe made from the new method will possess better bending and threading properties than those found in hand puddled products.

The new mill affords the manufacturer facilities for producing plate and iron bar, although it is thought that for some time to come wrought-iron pipe will be the finished product.

Three Time Winner of Safety Trophy

Mayor C. F. Snively and R. J. Fisher, president of the Advisory Public Safety committee, of Duluth, were the principal speakers at the recent field day celebration of the Duluth plant of the Universal Atlas Cement Company as winner for the third time of the no-accident safety trophy.

The trophy was presented by George A. Ricker, representing the Portland Cement Association, and was accepted for the Duluth plant by Fred Robinson, assistant superintendent.

A colorful feature of the celebration occurred when 955 gas-filled balloons were brought onto the field by 32 boy scouts, each scout representing one month of the mill's consecutive no-accident record, and after the boys had formed the letters "SAFETY" the balloons were simultaneously released.

Each of the balloons carried a tag bearing a safety message, a "Safety Crusader" badge of the National Safety Council, and a reproduction of a safety poster. Prizes were offered to the finders of the balloons traveling farthest from the Duluth plant. Each tag carried the name of an employe, and prizes were awarded to the employes whose balloons traveled farthest.

Following the ceremonies attendant upon the unveiling of the trophy, a picnic luncheon and athletic events completed the program.

Wallace & Tiernan Make Changes in Personnel

F. G. Merckel, for the past eight years manager of Wallace & Tiernan Company's Chicago office, has been appointed sales manager of Wallace & Tiernan Products, Inc., with headquarters at Belleville, New Jersey, according to recent announcement in regard to several personnel changes.

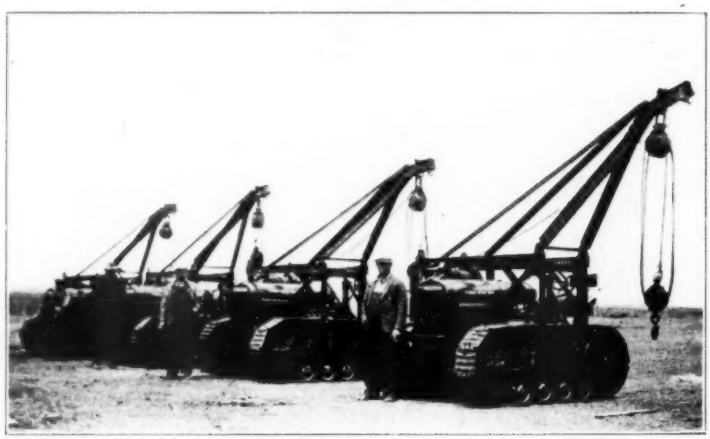
The position left vacant by Mr. Merckel will be filled by C. O. Bruden, formerly assistant manager.

In the Indianapolis district, W. A. Hockett has been transferred from the position of manager of the district office to the home office of the company at Newark, New Jersey, to take charge of the foreign activities. E. F. Kinney has been appointed district manager to succeed Mr. Hockett.

Charles H. Eastwood, who was formerly in charge of foreign sales, has been placed in charge of advertising and publicity for the Wallace & Tiernan Company and Wallace & Tiernan Products, Inc.

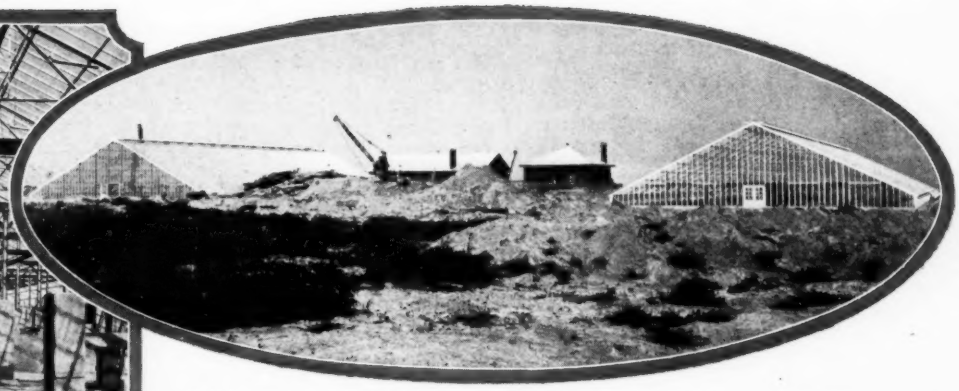
European Correspondent for Link-Belt Co.

William Piez, brother of Charles Piez, chairman of the Link-Belt Company, has been appointed European correspondent, according to recent announcement of Humphrey L. Kiely, head of the export division. His Paris address will be Hotel Lutetia, 43 Boulevard Raspail.



They Reach for a Pipe

Part of a fleet of Trackson-McCormick Deering crawler tractors with Seminole pipe handling booms which were recently purchased from the Industrial Machinery Company of Kansas City by Knupp & Fredell, Kansas pipe line contractors.



All-Steel glass sludge bed enclosures *for Dunkirk*

The new sludge bed plant of the City of Dunkirk, New York, is equipped with two American-Moninger glass sludge bed enclosures of all-steel construction. One enclosure is 75 feet wide by 125 feet long and the other is 74 feet wide by 250 feet long. The use of these glass sludge bed enclosures permits three or four times the number of dryings as compared with open sand beds.

American-Moninger has ample facilities to handle all types of sludge bed coverings. Preliminary plans and specifications furnished on request. Write for estimates.

Since 1869

American-Moninger Greenhouse Manufacturing Company

SOUTHWEST OFFICE
2611 North Dewey St.
Oklahoma City, Okla.

1365 Flushing Avenue
Brooklyn, New York

WESTERN OFFICE
1313 W. Randolph Street
Chicago, Ill.

THE MOST IMPORTANT INGREDIENT IN YOUR PIPE COATING IS

EXPERIENCE

The best solution to any of the problems that come up in the business of coating pipes is knowledge. Robertson has the knowledge. The H. H. Robertson Co. is the world's largest producer of special asphalts. It has made investigations in the action of soils on coating materials. It can determine the exact combination of asphaltic bases that are best calculated to protect your pipe under any given set of conditions . . . and it can produce exactly that combination.

Specify Robertson coatings on your pipes.

H. H. ROBERTSON CO.,
PITTSBURGH, PA.

ROBERTSON HAS THE EXPERIENCE

Retirement of Geo. W. W. Cornman Announced

Announcement has been made of the retirement of George W. W. Cornman, treasurer and manager of the Service Department of The Brown Instrument Company of Philadelphia.

Mr. Cornman, who was formerly secretary and treasurer of the Keystone Electrical Instrument Company, has been associated with the instrument business for 35 years. When the Brown Company absorbed Keystone, Mr. Cornman was made a director and treasurer, and under his guidance built up the service department, of which he was the head.

The service department is now in charge of R. C. Kennan, manager, and E. T. Nahill, field supervisor.

T. L. Lewis Joins Norvell-Wilder Supply Company

T. L. Lewis, who for the past 18 years has been associated with the A. M. Byers Company of Pittsburgh, has resigned to become associated with the Norvell-Wilder Supply Company of Beaumont, Texas, distributors of oil country goods. For the past 12 years Mr. Lewis has served the Byers company as general manager of sales.

Another change in the ranks of the Byers company has been caused through the resignation of George E. Clifford, Pittsburgh division manager, who has been made assistant sales manager of the pipe division of the Republic Steel Corporation.

Worthington Pump Reports Improved Financial Status

A recent report issued by the Worthington Pump and Machinery Corporation of Harrison, New Jersey, in addition to maintaining good earning power indicates an improved financial status during the first half of the year.

As of June 30, current assets were $17,525,690 against current liabilities of $1,225,722. Cash, call loans and government security holdings were reported as $6,920,560, 465% in excess of total liabilities. Inventories, as of the same date, totaled $5,662,733; reserves $1,674,920; and surplus $5,701,103.

Corresponding figures for the first six months of 1929 were: Current assets, $16,532,255; current liabilities, $813,707; cash, call loans and government securities, $5,645,932; inventories, $6,649,069; reserves, $1,896,622; and surplus, $5,028,025.

The net income of $1,052,732 for the first half of 1930, after deducting all charges, including taxes and depreciation, was reported as substantially larger than the total net for each of the full years 1922 to 1928, inclusive, and only $46,696 less than that reported for the corresponding period of 1929.

The first half net of this year was equal to $4.31 a share on the 126,921 shares of $100 par common stock outstanding, compared with $4.57 a share on 129,921 shares of common issued in the first half of 1929.

J. R. Dangler Made Secretary Cast Iron Pipe Research

Announcement has been made to the effect that the Standardization and Development Committee of the Cast Iron Pipe Research Association has secured the services of J. R. Dangler as secretary to handle the standardization and development work of the cast iron pipe industry.

Mr. Dangler's office will be located at 923 Union Trust Building, Cleveland, Ohio. Mr. Dangler has formerly held executive positions with the Massillon Iron and Steel Company and the Central Steel Company of Massillon.

New Representatives for Paradon Mfg. Co.

The Industrial Sales Company have recently taken on Mr. Miller, who will specialize in the service and sale of Paradon chlorinators in the Omaha territory. Nebraska and western Iowa are included in the territory to be covered.

Percy L. Luck will represent the Paradon Company in the states of Louisiana and Mississippi. Mr. Luck will have a complete stock of parts, as well as chlorinators, to aid him in the sales and service work for Paradon. This manufacturer was formerly represented in this territory by the firm of Buckmaster-Luck-Malochee, Inc.

New San Francisco Plant for Link-Belt Co.

A modern plant, employing the latest designs in tools, most up-to-date methods of production, and an engineering organization capable of applying labor-saving machinery for every industry, describes the new manufacturing plant and office of the Pacific Division of the Link-Belt Company. It is located at Paul Ave. near Bayshore Highway.

The office building is of Spanish design, two stories high; the warehouse 80x120 ft., is three stories high, and the manufacturing building, containing the machine shop, steel shop, plant office and their auxiliary departments completes the unit.

All kinds of elevating, conveying and power transmission machinery is manufactured within the plant, assuring quick and efficient service to the Link-Belt customers, and is one more well equipped unit in the Link-Belt's 16 plants and warehouses located throughout North America.

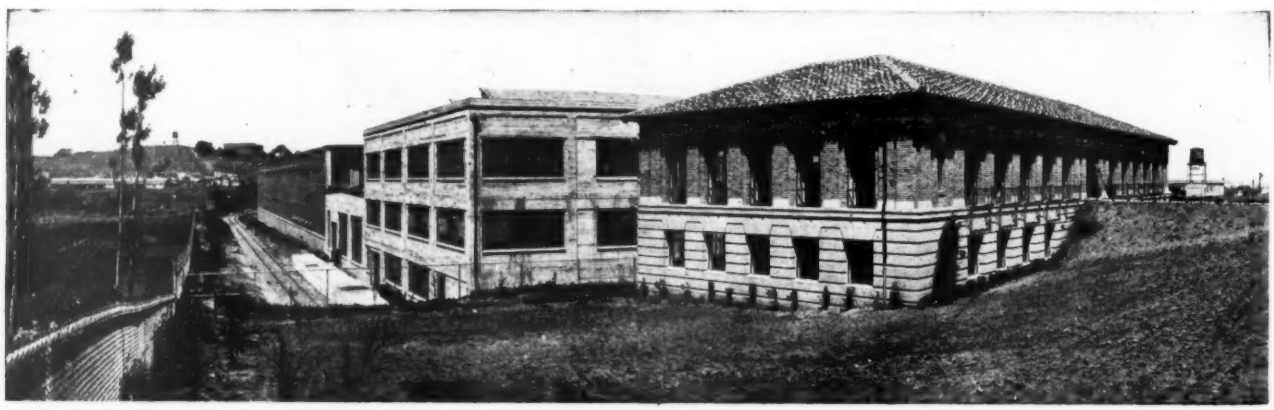
What's Your Guess?

A guessing contest on tensile strength of oxy-acetylene welded test coupons which will be pulled on the Oxweld Portable Tensile Testing Machine, will be a feature of the exhibit of the Union Carbide and Carbon Corporation at the National Metal Congress and Exposition where the subsidiaries of this corporation will occupy Booths 81 and 82 to display their products.

The exposition is to be held at the Stevens Hotel in Chicago from September 22 to 26, and will be the twelfth annual National Metal Congress. Among the units of the Union Carbide organization participating will be The Linde Air Products Company, The Prest-O-Lite Company, Inc., Oxweld Acetylene Company, Haynes Stellite Company, The Oxweld Railroad Service Company and Union Carbide Sales Company.

"Everything for Oxwelding and Cutting Everywhere" will be emphasized by displays of Linde oxygen, Prest-O-Lite acetylene and small tank apparatus; welding and cutting blowpipes; carbide in drums, flood lights and carbic and processed carbide.

The booths of the Union Carbide will be in charge of E. J. Hayden of the Chicago office and H. H. Griffith of the New York office. H. F. Bulkley and T. C. Fetherson of the New York office and several Chicago sales representatives will also be in attendance and the Oxweld Railroad Service men are looking forward to greeting some of their railroad friends who will be in Chicago at the same time attending the Railroad Master Blacksmiths' Association Convention.



San Francisco Plant of Link-Belt. Front to back, in order: Office Building, Warehouse, Shipping Room and Manufacturing Building

PITTSBURGH DES MOINES

300,000 gallon tank on a 100 foot tower at Grinnell, Ia. The tank is 36 feet in diameter, 28 feet 1¼ inches high with a riser 48 inches in diameter. Completed June, 1930.

Cut the Costs
of Forced Pumping

Water pumps that labor 24 hours a day to keep mains full are no longer necessary. By filling an elevated tank during slack hours, the same pumps can create a cost-saving reserve supply of water in a PDM tank of proper capacity, that will service the entire city adequately during peak load hours.

A strong elevated gravity pressure will save the cost of torn-up streets to install larger water mains. Inadequate service often results from the *low pressure* available, and *not* from too small water mains.

Our 48 page Municipal Water Works Catalog tells how other cities have cut their water supply costs. Write for a copy.

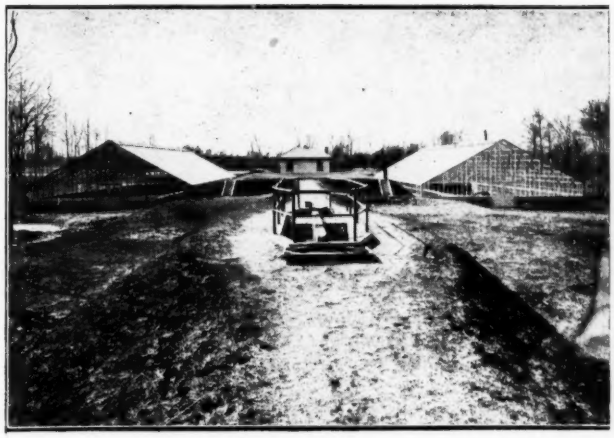
Pittsburgh-Des Moines Steel Company

3404 Neville Island, Pittsburgh, Pa.
906 Tuttle St., Des Moines, Ia.

New York
Dallas
San Francisco

Chicago
Atlanta
Seattle

Sewage Disposal need not be *disagreeable!*



King Sludge Bed Enclosures Are Attractive in Appearance And Give Perfect Odor Control . . .

This scientific method of sludge drying effectively eliminates the big objection to sewage disposal plants, viz., the constant odor. With King Enclosures, this odor is controlled by a ventilating system which renders it negligible. A slight soapy smell, occasionally, is all that is ever detected.

There are other advantages. In consequence of the elimination of the disagreeable odor feature, it is now possible to locate the disposal plant nearer to the center of population. The economy of this is obvious. Sludge bed capacity is increased, too, with King Enclosures: It being possible to serve twice the population without enlarging the beds. Sludge drying proceeds efficiently the whole year, regardless of the weather. Sludge may be run to a greater depth and dried more quickly.

We should be pleased to send you full particulars. No obligation. Just mail us your letterhead.

Plant shown above: Two 48x97 ft. King Enclosures erected for Boroughs of Bergenfield & Dumont at Dumont, N. J. Engineer: Thomas F. Bowe.

KING CONSTRUCTION COMPANY
533 Wheatfield Street
North Tonawanda, N. Y.

NEW YORK CITY PHILADELPHIA, PA. BOSTON, MASS.
SCRANTON, PA. TOLEDO, OHIO SCHENECTADY, N. Y.
BRIDGEPORT, CONN.

OUR CATALOGUE IS FILED IN SWEET'S

Frank J. Oakes, Well Known Engineer, Dies

Apoplexy was the cause of the sudden death of Frank J. Oakes at his Indianapolis home on July 19th. Mr. Oakes was general superintendent of the Dodge Works of Link-Belt Company of Indianapolis. He was 54 years old, and well known in the mechanical engineering field.

Mr. Oakes was born in Decatur, Ill., in 1875, and entered the service of the Link-Belt Machinery Company of Chicago in 1894, as repairman and general machinist. In 1899 he obtained a year's

Frank J. Oakes

leave of absence to serve as repair man for the Mexican Central Railway in Chihuahua. Returning to the Link-Belt Company in Chicago he continued to serve as repairman and as assistant foreman in the sheet and structural iron department. In 1913 he was transferred to Philadelphia, and two years later went to Indianapolis to become general superintendent of the Dodge Works, which position he held until his death.

He was a recognized authority on mechanical engineering and during the World War was selected by the government as a designer and adviser on the manufacture of munitions. He was sent to Europe by the Link-Belt Company to investigate new mechanical inventions and to study chain manufacturing processes. He was a pioneer in developing processes for the heat treatment of steel and contributed valuable information to heat treaters as a result of his experiments. He also held patents on inventions in the chain industry and in other fields.

Mr. Oakes was active in local business and lodge circles. He was a member of the Society of Automotive Engineers, the American Society of Steel Treaters, the American Gear Manufacturers' Association and several other engineering societies. He was a past master of Evergreen Lodge, A. F. and A. M., a member of the Shrine, the Knights Templar and the Odd Fellows. He was also a member of the Avalon Country Club of Indianapolis. Engineering and industry has lost one of its leaders.

International Nutyp Successor to Oswego Tool Company

A complete change of management was announced with the sale of the Oswego Tool Company to the International Nutyp Tool Corporation of Oswego, New York.

H. W. Stone, formerly president of the U. S. Hoffman Machinery Corporation, has been made president and general manager of the new corporation. E. B. Russell, formerly head of the Security Finance Company and sales manager for Peerless Mills, Inc., will serve the new company as vice-president and treasurer, and E. W. Fulton, who for several years has been manager of the Oswego Tool Company, will become works manager and vice-president of the company.

It is stated that a new system of merchandising will be put in operation, and new tools will be added to the Oswego line. It is possible that some contemplated mergers of other companies with International may bring about a further expansion of this organization.

Chain Belt Announces New Distributors

The following distributing companies have recently been appointed to handle the complete line of Rex construction equipment manufactured by the Chain Belt Company of Milwaukee:

The Equipment Corporation of Arizona at Phoenix; F. C. Crane Company, Dallas, Texas; Joe C. Tucker, Morganfield, Ky.; Track-Type Tractor and Equipment Company, Amarillo, Texas, and Concrete Products Company of Oakland, Cal.

In addition to the new construction equipment distributors, the Chain Belt Company has appointed the E. C. Atkins and Co., Inc., Memphis, Tenn., as chain and power transmission representatives. The Atlanta office of the company has recently been moved to 407 Bona Allen Building.

Guiler to Represent Ateco in Pacific Northwest

Homer L. Guiler, for the past four years connected with Hofius-Ferris

Homer L. Guiler

Equipment Company of Spokane, has been appointed district representative in the Northwest for the American Tractor Equipment Company, according to announcement of Edward R. Bacon, president of the firm, which manufactures Ateco earthmoving equipment.

Mr. Guiler, according to announcement, is thoroughly familiar with earthmoving, particularly in the Northwest, having been in the machinery business for 10 years, always as a salesman of tractors or graders. Prior to his connection with the Hofius-Ferris Company he was employed by the Connelly Machinery Company, "Caterpillar" dealer of Billings, Montana, and by the Northwest Equipment Company of Butte.

He has been assigned the entire Pacific Northwest for the American Tractor Co. and will cover Oregon, Washington, Idaho, Wyoming, Montana, Utah, North Dakota, South Dakota and Minnesota.

C. B. Spicer Retires

After 43 years of continuous service in the explosive business, Charles B. Spicer, resident manager of the St. Louis office of the Hercules Powder Company, has retired, according to recent announcement.

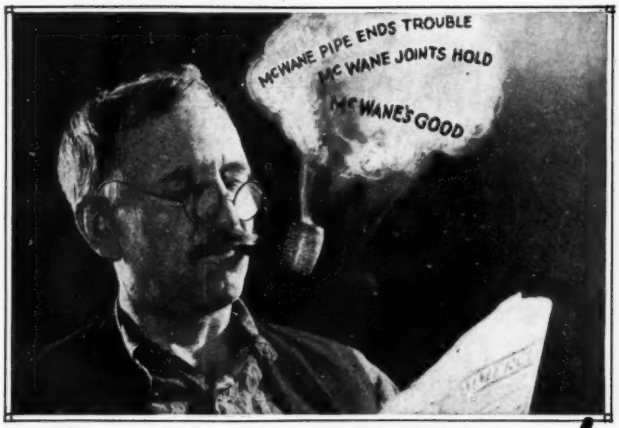
Born in St. Louis in 1869, where he received his education, Mr. Spicer entered the explosive business as an office boy for the Hazard Powder Company, subsequently becoming a salesman for them. He went to Pittsburg, Kansas, as an explosives sales agent, and in 1913 was made manager of the Pittsburg office for the Hercules Powder Company. In 1921 he was transferred to his home town as resident manager in charge of the Southwestern district.

Mr. Spicer, while in Pittsburg, Kansas, was active in civic affairs, serving as president of the Chamber of Commerce, and also was Exalted Ruler of Elks. He is now making his home at 742 Boland Drive, St. Louis.

The Independent Pneumatic Tool Company, Chicago, manufacturers of Thor Pneumatic and Electric Tools, have appointed Mr. C. T. Connelly manager of the Buffalo office. Mr. Connelly formerly worked in the Michigan territory out of the Detroit office.

Service Exchange has been helpful in securing desirable representation for the products of many manufacturers and in assisting distributors in building up their lines. Do not hesitate to make use of this service which the publishers present as a regular feature of this magazine. For information write, Editor, Distributor News.

Following the trend of the times, McWane Cast Iron Pipe Company, of Birmingham, Ala., tie up their pipe stories with events of the day and tell them in picture tabloids in their little paper called "Pipe Pointers."



Two Pipes of Peace!

To have peace in his mind, a waterworks man's got to have cast iron pipe in his mains. *Then* the old cob pipe "hits on all six" when his day's work is done; he knows rust and rot cannot harm his distribution system this year, next year—or next century. Cast iron *lasts*.

And the wiser ones have extended a good idea downward too, into the 1¼ and 2 inch sizes—adopted McWANE cast iron pipe for the small outlying lines, for the newly-popular two-main systems in residential blocks, and for services everywhere.

Get New Booklets

Bring your pipe-facts up-to-date with the new McWane booklets. Learn of new advantages, new uses for cast iron pipe in your field. 2-inch pipe in 18-foot laying-lengths now. New sizes of Precalked Joint and open bell B. & S. McWane pipe—up to 12 inches. At least *find out* what McWane pipe can do for you.

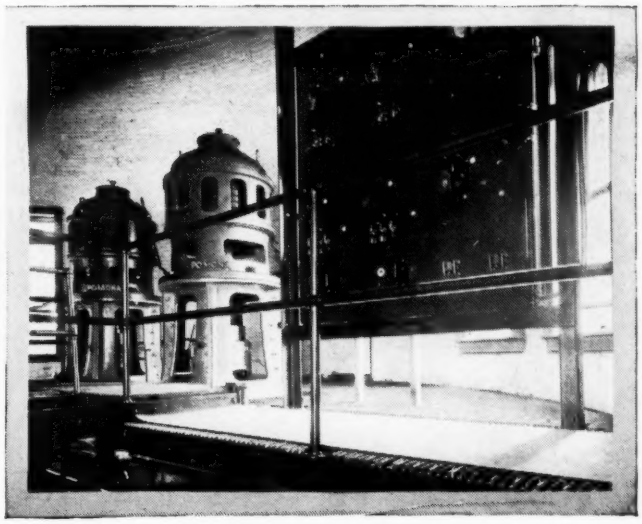
WRITE FOR ILLUSTRATED LITERATURE

McWANE
CAST IRON PIPE

McWANE CAST IRON PIPE COMPANY
BIRMINGHAM, ALA.

PACIFIC STATES CAST IRON PIPE COMPANY
PROVO, UTAH.

SALES OFFICES, PRINCIPAL CITIES



Two 400 H.P. Pomona Turbine Pumps installed for the City of Augusta, Georgia.

Pumps that stay young

Pomona Turbine Pumps are designed and built to give many additional years of dependable service. Municipal Water engineers have found that these water-lubricated pumps assure an absolutely clean water supply. Pomona Pumps do not require frequent inspection, a factor which makes them unexcelled for automatic operation.

Factory representatives, sales and service offices in all principal cities. Name of nearest one and Bulletin on request.

Pomona Pump Co., Pomona, Calif.

POMONA

WATER LUBRICATED TURBINE TYPE

Oceans of Water

PUMPS

[Ask for Catalog]

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives of their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Water works equipment distributor, covering northeastern Indiana, would like to secure representation of a line of chlorinators.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Distributor covering northern California, having warehouse facilities, would like to secure line of water meters, pipe jacks or pushers, flow meters, and sewage treatment and disposal material and equipment.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

West Coast distributor, specializing in materials for sewers and water works, is in a position to render splendid representation for territory covered.

Manufacturer's representative, with warehouse facilities available, would like to secure additional lines in water works and sewerage and general contracting fields. Covers Houston and San Antonio territory.

Wanted for Buffalo, Niagara Frontier and Western New York territory a good power and heating boiler account.

Manufacturer's representative now handling centrifugal pumps would like to secure other lines in water works field. Covers eastern Pennsylvania, south Jersey and Delaware.

Water Works equipment distributor, covering northeastern Indiana, would like to secure representation of a line of chlorinators.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Distributor covering northern California, having warehouse facilities, would like to secure line of water meters, pipe jacks or pushers, flow meters, and sewage treatment and disposal material and equipment.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturer's representative located in New-York City, now handling pumping machinery, would like to take on two or three additional lines serving the same field as his present account.

Michigan distributor would like to add two or three good lines to serve territory in southwestern part of state.

Machinery distributor, established in Porto Rico and Santo Domingo, would be pleased to make arrangements to take on new lines in these territories.

Manufacturer's representative, covering Massachusetts, Rhode Island and southern New Hampshire, would like to secure line of speed reducers and gears.

Manufacturer's representative with 25 years sales experience, conversant with all types of pumps and their field, desires agency for either New York or export territory, or both.

▼

Representatives Wanted

Manufacturer of special valve and hydrant lubricant wishes to establish distributing points throughout the country.

Manufacturer of centrifugal pumps for water works, sewage plants, sand and dredging plants, process industry, contractors, etc., desires to secure additional representation. Attractive territory available.

Well established manufacturers' representatives wanted to handle sand and gravel pumps and equipment, in key cities, by successful manufacturer of high grade dredging pumps and hydraulic dredging equipment. Give character of equipment now being handled and territory covered.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Distributors wanted for deep-well turbine pumping unit. Product serves small industrial plants, private estates and farmers.

Manufacturer of water works brass goods would like to make proposition to manufacturers' representatives calling on water works' trade.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

District representatives wanted for sanitary engineering specialty used extensively in the water works, sewage and swimming pool fields.

Manufacturer of air compressors and contractors' tools has number of desirable territories open. Full co-operation will be extended to distributors.

Distributors wanted to represent improved type of snow fence. Good territory in various parts of country.

Manufacturer of contractors and builders levels and transits is seeking district sales manager. Exclusive contract given. Excellent territory still available. Backed by national advertising.

One of the leading manufacturers of surveying instruments in the United States is seeking responsible agents in all sections of the country. Instruments are nationally advertised in all leading engineering journals.

•

Just Enough Heat

The Marsh weather compensating system of heating is to be installed in the new Connecticut State Office Building at Hartford and in the palatial sixty-room residence of Harry Barnes at New Britain, Conn., according to information recently given out by the manufacturers, James P. Marsh and Company of Chicago.

The system employs automatic methods to deliver only sufficient steam to maintain a constant temperature of approximately 70 degrees, and is said to effect considerable saving in fuel consumption when weather conditions do not place full demand upon the heating plant.

•

A Note from Abroad

The following announcement has been received from England regarding the amalgamation of the Alloy Welding Processes, Ltd., and the Premier Electric Welding Company:

"Practically the whole of the issued shares of Alloy Welding Processes, Ltd., of Ferry Lane, Walthamstow, E. 17, have been purchased by Messrs, Murex, Ltd., who possess works at Rainham, Essex, and whose business is the treatment of complex ores and the manufacture of various alloys and of carbon free metals.

"Messrs. Murex, Ltd., own all the share capital of the Premier Electric Welding Company, Ltd., also that of Thermit, Ltd. The works of the Premier Electric Welding Company, Ltd., will be shortly removed to the works of Alloy Welding Processes, Ltd., as the latter company have ample space to accommodate them in their new factory, of which they took possession about eighteen months ago."

•

Service Exchange Department is to assist in building up strong distribution organizations. Use it.